

The Virtual Observatory: A New Revolutionary Way of Scientific Research

Astroinformatics, e-Science

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Astroinformatics and VO Summer School
Faculty of Mathematics, University Belgrade, 30-th June 2010, Serbia

Outline of the Talk

- VO – the hidden revolution in astronomy
- Data Avalanche in astronomy
- History of VO
- Basic principles of technology
- VO Tools
- Theory in VO
- VO Science
- VO and Society

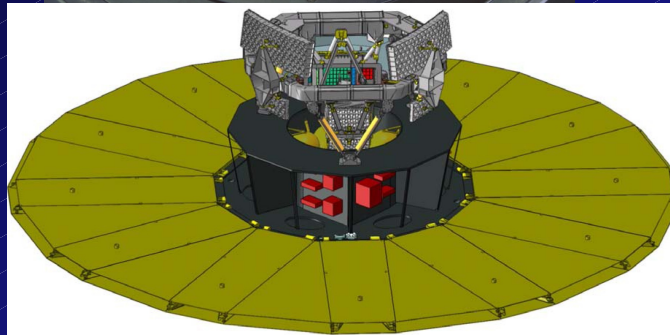
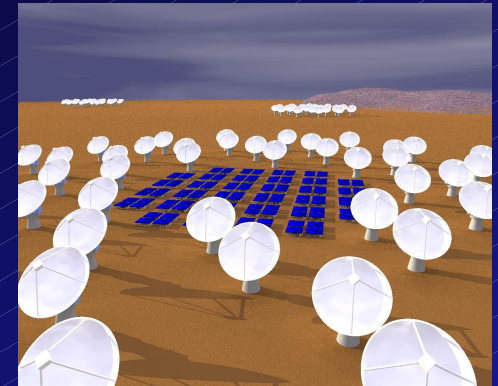
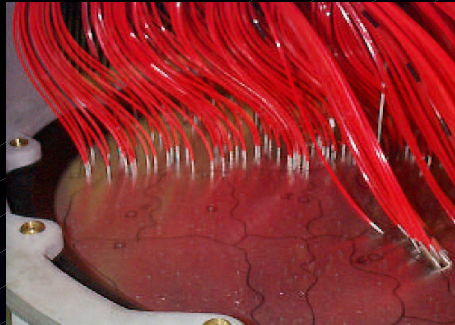
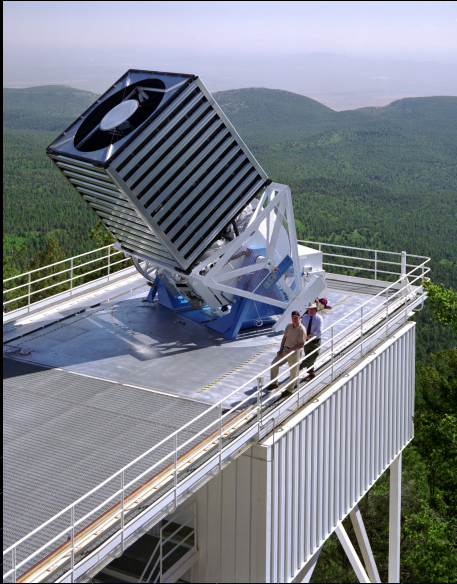
VO - The Hidden Revolution

- VO is the radical change of the paradigm of the work of the scientists – effectiveness !!!
- Everyday question (what, where, format, units)
- Everyone is using it – but not stated (> 5 years)
 - CDS (Simbad, Aladin, Vizier), NASA, ESA archives
 - All looks like „ONLY“ another WEBS, client apps
- Scientists are conservative (don't like change)
 - The fear of buzzword VO (multispec, large scale)
- Computer literacy – obligatory (part of job)

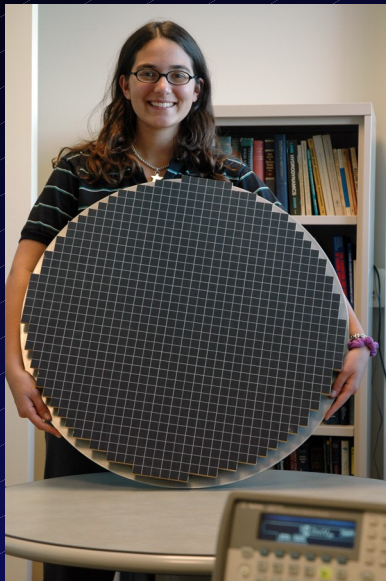
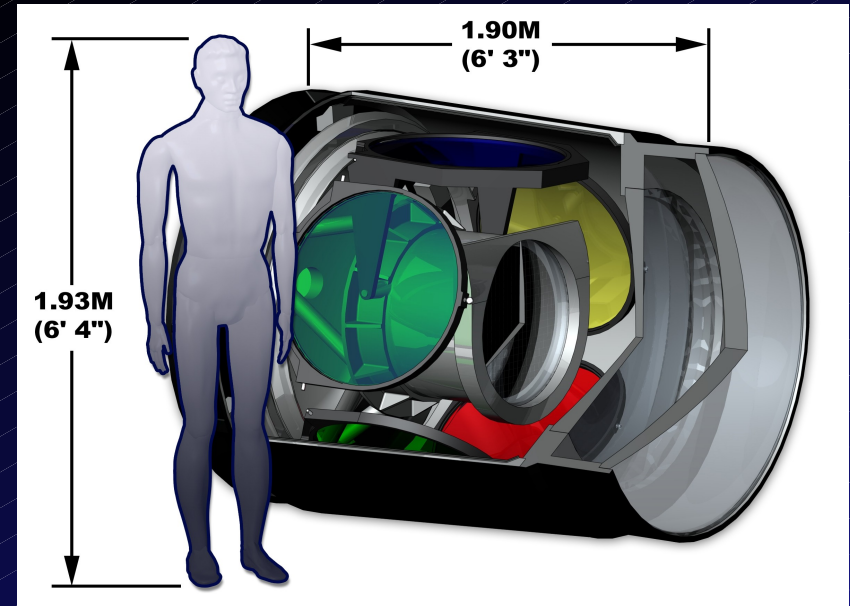
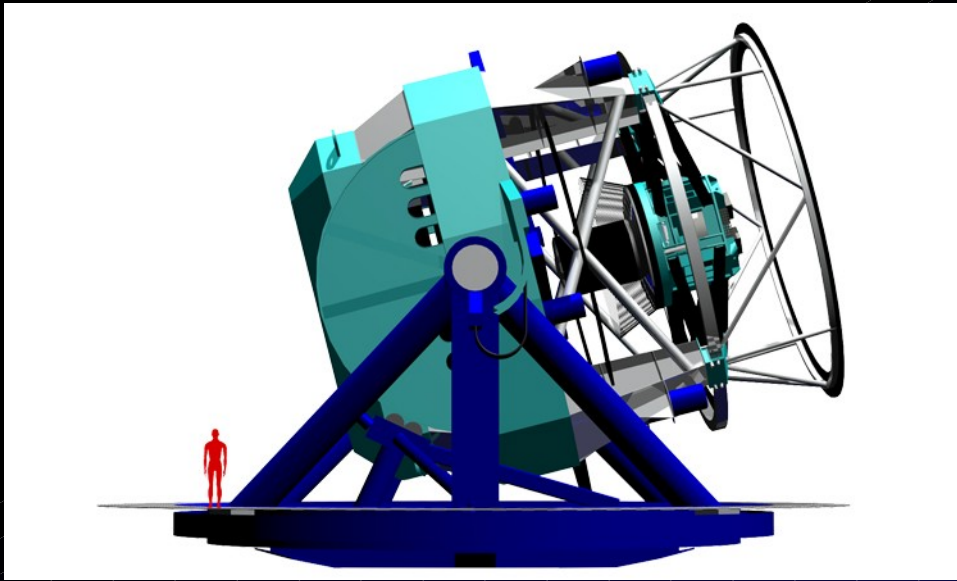
Analogy between VO and WWW

- Linking HYPERTEXT/DATA among servers
- Synergy effect of GLOBAL NET (Gopher, WAIS)
- Powerfull SEARCH (VERONICA – GOOGLE)
- DISTRIBUTED but CENTRAL Steering Organisation (W3C/IVOA)
- Recommendations = „Obligatory“ Standards
- Astronomers in forefront of development
- Scepticism (usefulness for my field ???)
- Steep Growth – average user can use it without knowledge of principles (effectivity, habits)

Data Avalanche



LSST (8.4m)

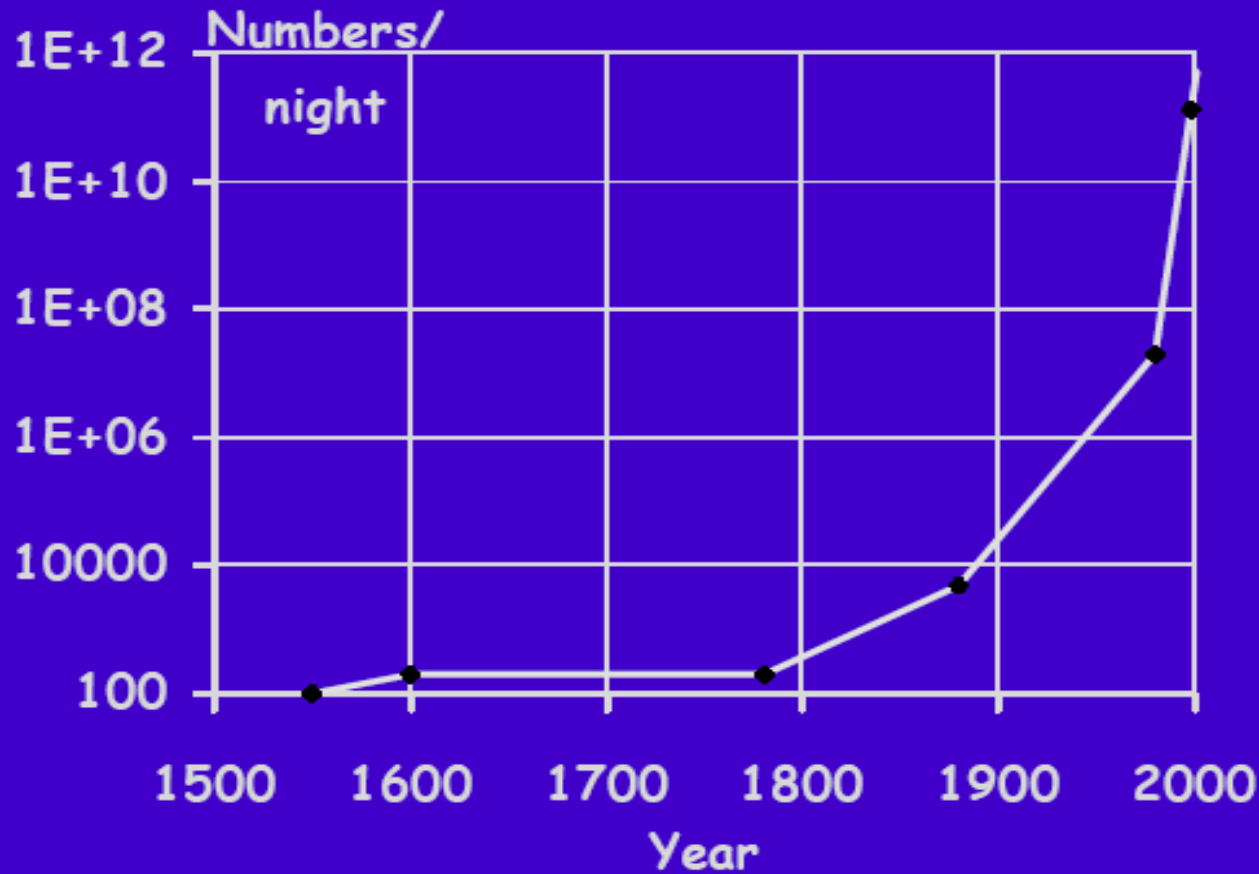


200 CCD 4kx4k,
32 channels (6400)
3.2 Gpix every 20 sec
64cm diameter
3.5 deg FOV
30 TB/night
2 TFLOPS
detection of changes
within 60sec

Data Avalanche

Moore law for chips –doubling 1.5 year

Data in astronomy – doubling < 1 yr ! (1000/10 yr)



$T_2 < 18$ mths
1990-2000

History of VO

Success of IUE/HST archives

idea of the VO - end 2000

Federation of archives (MAST, NED)

unified IF, data format for transport

Huge data – distributed processing

GRID - started in HEP (accelerator science)

Multispectral research : radio---gamma

Virtual Universe (UK), AstroVirTel (ESO)

Data for SDSS, SIMBAD, NED – key research

Virtual Observatory : Key Definitions

- *“The Virtual Observatory will be a system that allows astronomers to interrogate multiple data centers in a seamless and transparent way, which provides new powerful analysis and visualization tools within that system, and which gives data centers a standard framework for publishing and delivering services using their data”.*
- Standardization of data and metadata, and of data exchange methods.
- Registry, listing available services and what can be done with them.

R.J.Hanisch, P.J.Quinn, in “IVOA – Guidelines for participation”

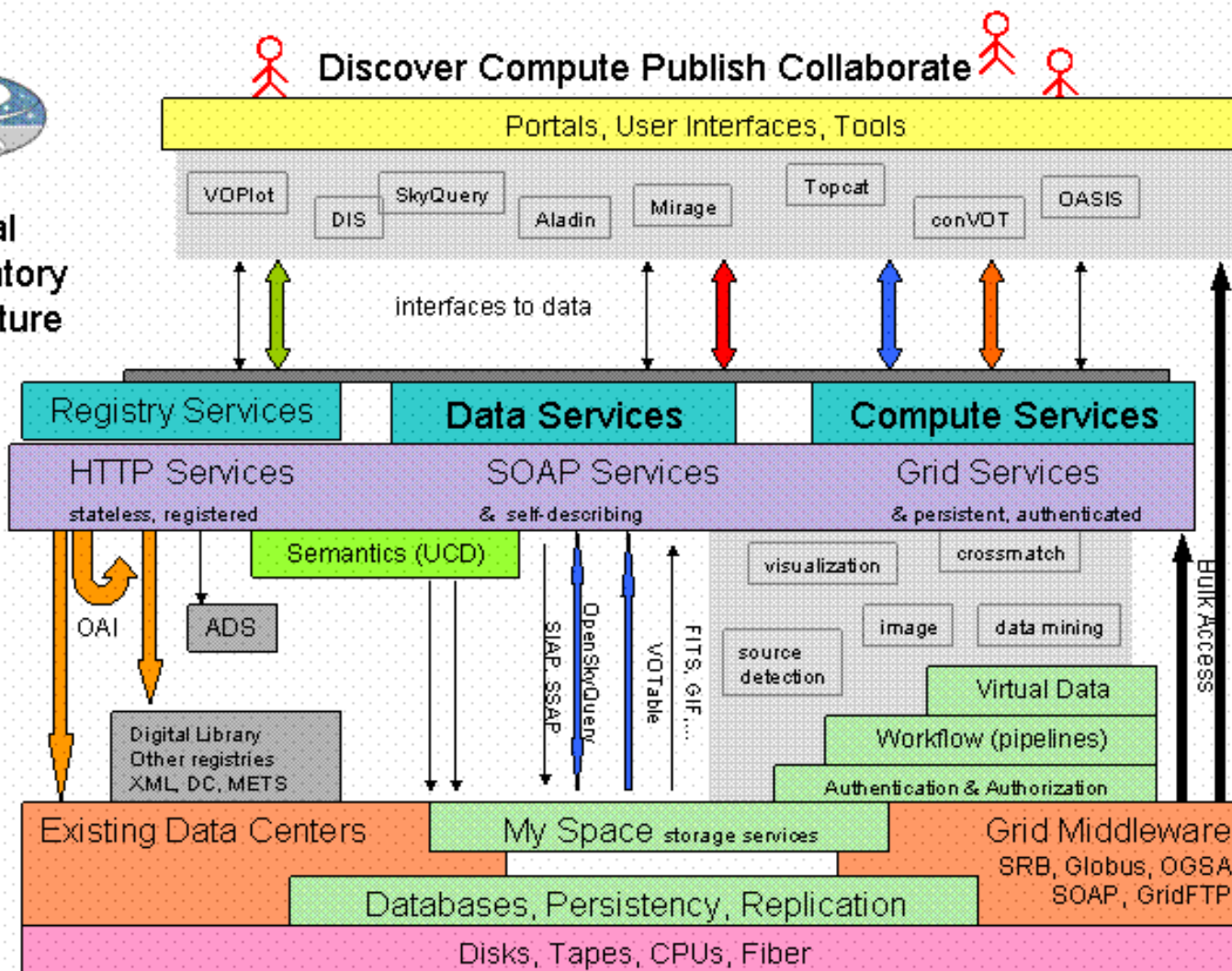
VO Paradigma

- METADATA (name of column), ontologies (name)
- Unique format (VOTable – e.g Vizier)
- Transparent search, download, conversion
- Query for data – processing done on servers
- Federation of astronomical archives (protocols)
- Unified presentation – automatic units conversion (A, MeV, MHz \rightarrow nm), $\text{Wm}^{-2}\text{s}^{-1} \rightarrow \text{Jy}$)
- Background computing on GRIDS
- Multiwavelength approach (SED)

Architecture of VO



Virtual
Observatory
Architecture



Technology of VO

Unified data format– VOTable, UCD (Vizier)

Transparent transport (SOAP , REST_(youtube))

Web services (WS) e-commerce, B2B, J2EE, .Net

VOregistry (DNS like) Google for data+WS
protocols (CGI)

ConeSearch (searching in circle on sky)

SIAP (Simple Image Access Protocol)

SSAP(Simple Spectral Access Protocol)

SLAP(Simple Line Access Protocol)

TAP (Table Access Protocol)

VOEVENT (transients, robotic telescopes, Sun)

VO Registry - web

HEROS OND CUTOUT: Resource Record Summary - Iceweasel

Soubor Úpravy Zobrazit Historie Zálžky Nástroje nápověda

http://nvo.stsci.edu/vor10/getRecord.aspx?id=ivo://asu.cas.cz/stel/heros/cutout vo registry vor10

Nejnavštěvovan... Getting Started Latest Headlines ELIAV, a. s. - Firmy.cz

VOSpec_Oct2007.png (PNG obrá... X HEROS OND CUTOUT: Resource ... X

NVO National Virtual Observatory

NVO Registry

NVO Home Search Publish Developers Help Contact Us

Hosted By Space Telescope Science Institute

Tip: [What's a "Resource"?](#)

Resource Record Summary

Catalog Service:
cutout server of HEROS archive of Ondrejov observations

Short name: HEROS OND CUTOUT
IVOA Identifier: ivo://asu.cas.cz/stel/heros/cutout
Publisher: [Stellar Department of Astronomical Institute of the Academy of Sciences of the Czech Republic](#) [+ [Pub. ID]]
More Info: <http://stelweb.asu.cas.cz/vo-archives/heros>

Status: active
Registered: 2008 Oct 24 21:13:08Z
[Get XML](#)

Description

This is the cutout server for the content of HEROS archive. Using the parametr BAND=11/12 prepares on the fly spectra extended only over given range of wavelengths. This archive contains about 6000 high resolution (R=20000) echelle spectra obtained by the HEROS spectrograph installed at the 2m telescope of the Ondrejov observatory since August 2000 to March 2003. The spectra exposed simultaneously in two channels (red 580-840nm, blue 370-560nm) were reduced by MIDAS HEROS pipeline including the merging of echelle orders, heliocentric correction and rebinning to steps of 0.1A. The intensities are in instrumental flux (not normalized).

More About this Resource

- [+] **About the Resource Providers**
This section describes who is responsible for this resource
- [+] **Status of This Resource**
This section provides some status information: the resource version, availability, and relevant dates.
- [+] **What This Resource is About**
This section describes what the resource is, what it contains, and how it might be relevant.

Available Service Interfaces

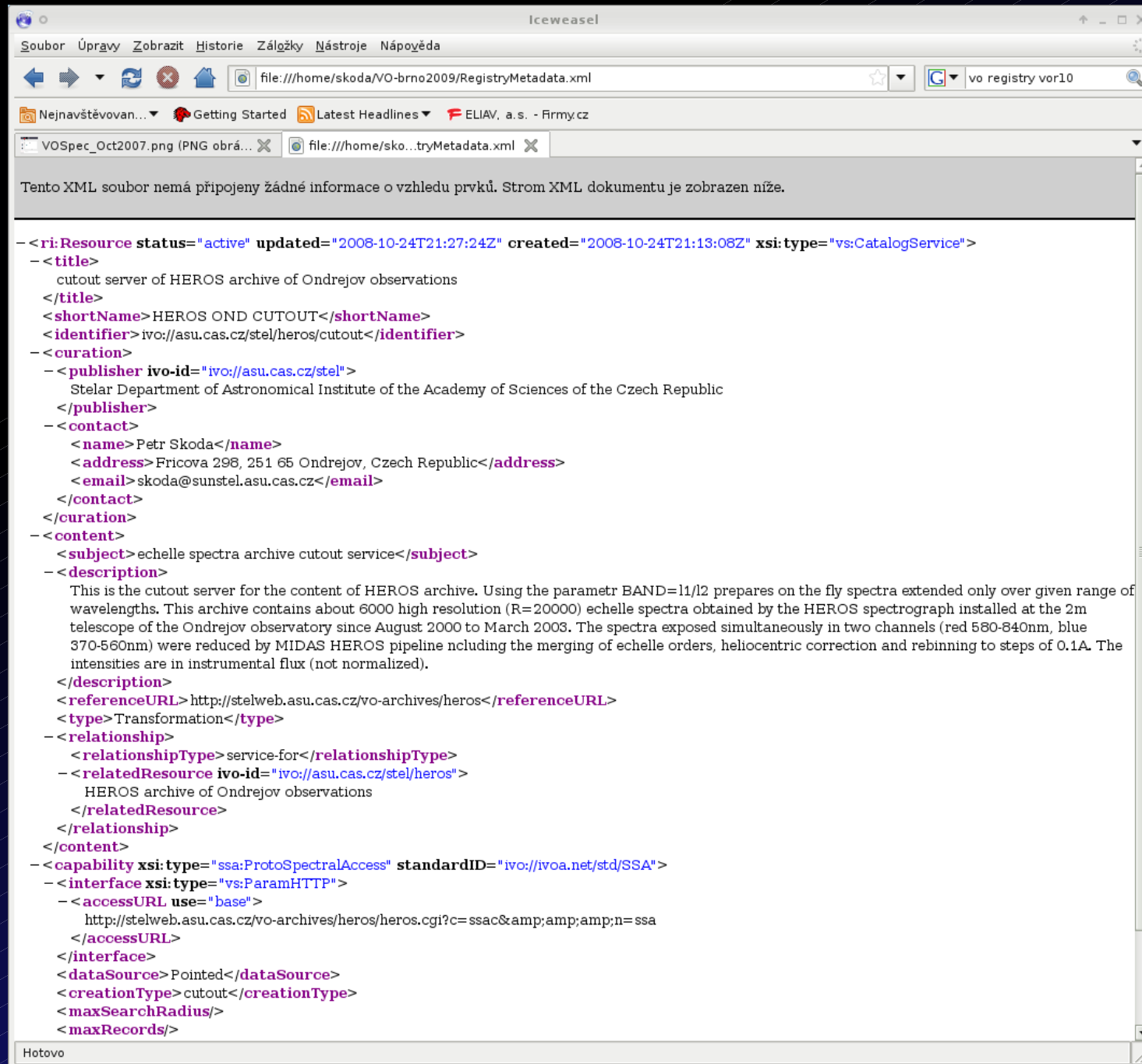
- [+] **Simple Spectral Access**
This is a standard IVOA service for searches for spectra from this resource that were observed within a specified region of the sky.

Developed with the support of the [National Science Foundation](#) under Cooperative Agreement AST0122449 with the Johns Hopkins University
The NVO is a member of the [International Virtual Observatory Alliance](#)
This NVO Application is hosted by the [Space Telescope Science Institute](#)

Member [Meet the Developers](#)

Hotovo

VO Registry - XML



Tento XML soubor nemá připojeny žádné informace o vzhledu prvků. Strom XML dokumentu je zobrazen níže.

```
- <ri:Resource status="active" updated="2008-10-24T21:27:24Z" created="2008-10-24T21:13:08Z" xsi:type="vs:CatalogService">
- <title>
  cutout server of HEROS archive of Ondrejov observations
  </title>
  <shortName>HEROS OND CUTOOUT</shortName>
  <identifier>ivo://asu.cas.cz/stel/heros/cutout</identifier>
- <curation>
  - <publisher ivo-id="ivo://asu.cas.cz/stel">
    Stelar Department of Astronomical Institute of the Academy of Sciences of the Czech Republic
  </publisher>
  - <contact>
    <name>Petr Skoda</name>
    <address>Fricova 298, 251 65 Ondrejov, Czech Republic</address>
    <email>skoda@sunstel.asu.cas.cz</email>
  </contact>
  </curation>
- <content>
  <subject>echelle spectra archive cutout service</subject>
  - <description>
    This is the cutout server for the content of HEROS archive. Using the parametr BAND=11/12 prepares on the fly spectra extended only over given range of
    wavelengths. This archive contains about 6000 high resolution (R=20000) echelle spectra obtained by the HEROS spectrograph installed at the 2m
    telescope of the Ondrejov observatory since August 2000 to March 2003. The spectra exposed simultaneously in two channels (red 580-840nm, blue
    370-560nm) were reduced by MIDAS HEROS pipeline including the merging of echelle orders, heliocentric correction and rebinning to steps of 0.1A. The
    intensities are in instrumental flux (not normalized).
  </description>
  <referenceURL>http://stelweb.asu.cas.cz/vo-archives/heros</referenceURL>
  <type>Transformation</type>
  - <relationship>
    <relationshipType>service-for</relationshipType>
    - <relatedResource ivo-id="ivo://asu.cas.cz/stel/heros">
      HEROS archive of Ondrejov observations
    </relatedResource>
  </relationship>
  </content>
- <capability xsi:type="ssa:ProtoSpectralAccess" standardID="ivo://ivoa.net/std/SSA">
  - <interface xsi:type="vs:ParamHTTP">
    - <accessURL use="base">
      http://stelweb.asu.cas.cz/vo-archives/heros/heros.cgi?c=ssac&amp;amp;n=ssa
    </accessURL>
  </interface>
  <dataSource>Pointed</dataSource>
  <creationType>cutout</creationType>
  <maxSearchRadius/>
  <maxRecords/>
</ri:Resource>
```

Hotovo

Technology of VO

ADQL (Astronomical Data Query Language)

XMATCH, REGION (2 catalogues - shifted)

Application interoperability – PLASTIC, SAMP

Allows develop applications as bricks

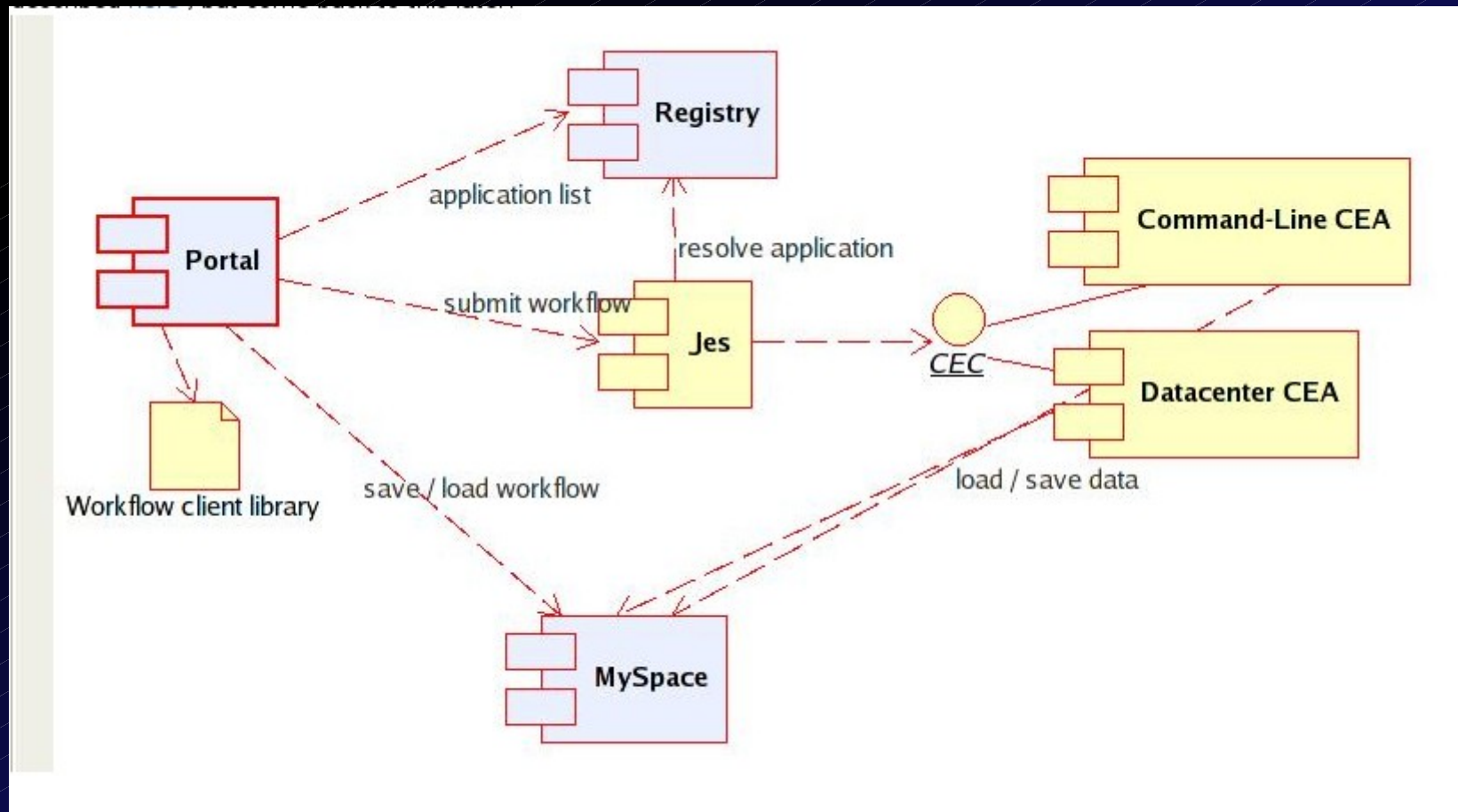
sending VOTABLES (catalogue-spectra-images)

Commercial interest (GoogleSky, MS WWT)

Planetariums, Outreach (Stellarium)

Workflows - Astrogrid

Running remote services – e.g. Sextractor, CASJobs, AstroNeural MLP....



Building a query

AstroGrid Query Builder

The screenshot shows the AstroGrid Query Builder interface for SDSS Data Release 3. The interface is divided into several main sections:

- Chooser:** A vertical sidebar on the left with tabs for Query, Parameter, XML, Info, and Security.
- Tree:** A central pane showing the query structure. The 'Select' section lists columns: a.ra, a.dec, a.u, a.g, a.r, a.i, a.z, a.err_u, a.err_g, a.err_r, a.err_i, a.err_z, a.type. The 'From' section is 'PhotoObj as a'. The 'Where' section contains two conditions: 'a.ra Between 242.0 And 243.6' and 'a.dec Between 54.1 And 55.1'.
- Table Description:** A pane on the right showing the description for the selected table: 'Maps all primary and secondary objects in the PhotoObjAll table to a view'.
- Table Columns:** A table below the description listing columns and their properties.

Name	UCD	Units	Type	Description
intMid	CO...			zU-deep ni...
fieldID	ID_...			Link to the ...
parentID	ID_...			Pointer to p...
specObjID	ID_...			Pointer to t...
u	PH...	mag		Shorthand ...
g	PH...	mag		Shorthand ...
r	PH...	mag		Shorthand ...
i	PH...	mag		Shorthand ...
z				
err_u				
err_g				
err_r	PH...	mag		Error in mo...
err_i	PH...	mag		Error in mo...
- Column References:** A dialog box titled 'Column References' is open, showing 'Insert 5 references into "Items"'. It is positioned over the 'u', 'g', 'r', and 'i' rows of the table.
- List of tables in the database:** A vertical list on the far right showing database tables such as SpecLineNames, SpecZStatus, SpecZWarning, TiMask, Tile, TilingBoundary, TilingMask, TiledTarget, SpecObj, PhotoFamily, PhotoObj (selected), PhotoPrimary, PhotoSecondary, SpecLine, SpecPhoto, Galaxy, and Sky.
- Query being built:** A callout points to the central query tree.
- Dialog to insert selected columns into selected section of the query:** A callout points to the 'Column References' dialog.
- List of tables in the database:** A callout points to the table list on the right.



VOTable :

```

<?xml version="1.0"?>
<!DOCTYPE VOTABLE SYSTEM "http://us-vo.org/xml/VOTable.dtd">
<VOTABLE >
  <DESCRIPTION>
    VizieR Astronomical Server: urania.iucaa.ernet.in          2002-10-04T05:20:16
    Explanations and Statistics of UCDs:                      See LINK below
    In case of problem, please report to:                    question@simbad.u-strasbg.fr
  </DESCRIPTION>
  <DEFINITIONS>
    <COOSYS ID="J2000" equinox="J2000" system="EQ_FK5"/>
  </DEFINITIONS>
  <INFO ID="Ref" name="-ref" value="VOTx11451"/>
  <RESOURCE name="V/105" ID="yCat_5105" >
    <DESCRIPTION>SKY2000 Catalog, Version 3 (Myers+ 2000)
  </DESCRIPTION>
  <TABLE ID="V_105_sky2v3r1" name="V/105/sky2v3r1" >
    <DESCRIPTION>The Sky2000 Version 2 Catalogue
  </DESCRIPTION>
    <FIELD datatype="int" width="6" name="HD" ucd="ID_ALTERNATIVE" >
      <DESCRIPTION>?Henry Draper &lt;III/135&gt; number
    </DESCRIPTION>
    </FIELD>
    <FIELD unit="h:m:s" datatype="char" ref="J2000" name="RAJ2000" ucd="POS_EQ_RA_MAIN" arraysize="13" >
      <DESCRIPTION>Right ascension (J2000) hours
    </DESCRIPTION>
    </FIELD>
    <FIELD unit="d:m:s" datatype="char" ref="J2000" name="DEJ2000" ucd="POS_EQ_DEC_MAIN" arraysize="13" >
      <DESCRIPTION>Declination degrees (J2000)
    </DESCRIPTION>
  </TABLE>

```

Display Data Of Selected Points

Close

Save As File

IVOA



EUROVO



Simple Spectra Access Protocol Spectral Data Model

Simple Spectral Access Protocol V1.04



International
Virtual
Observatory
Alliance

Simple Spectral Access Protocol

Version 1.04

IVOA Recommendation Feb 01, 2008

This version:

<http://www.ivoa.net/Documents/REC/DAL/SSA-20080201.html>

Latest version:

<http://www.ivoa.net/Documents/latest/SSA.html>

Previous version(s):

Version 1.03, December 2007
Version 1.02, September 2007
Version 1.01, June 2007
Version 1.00, May 2007
Version 0.97, November 2006
Version 0.96, September 2006
Version 0.95 May 2006
Version 0.91 October 2005
Version 0.90 May 2005

Editors:

D.Tody, M. Dolensky

Authors:

D.Tody, M. Dolensky, J. McDowell, F. Bonnarel, T.Budavari, I.Busko, A. Micol, P.Osuna, J.Salgado, P.Skoda, R.Thompson, F.Valdes, and the data access layer working group.



International
Virtual
Observatory
Alliance

IVOA Spectral Data Model

Version 1.03

IVOA Recommendation 2007-10-29

This version (Recommendation Rev 1)

<http://www.ivoa.net/Documents/REC/DM/SpectrumDM-20071029.pdf>

Latest version:

<http://www.ivoa.net/Documents/latest/SpectrumDM.html>

Previous versions:

<http://www.ivoa.net/Documents/PR/DM/SpectrumDM-20070913.html>

Editors:

Jonathan McDowell, Doug Tody

Contributors:

Jonathan McDowell, Doug Tody, Tamas Budavari, Markus Dolensky, Inga Kamp, Kelly McCusker, Pavlos Protopapas, Arnold Rots, Randy Thompson, Frank Valdes, Petr Skoda, and the IVOA Data Access Layer and Data Model Working Groups.

SSAP Parameters

4.1.1 Mandatory Query Parameters

The following parameters **must** be implemented by a compliant service:

<i>Parameter</i>	<i>Sample value</i>	<i>Physical unit</i>	<i>Datatype</i>
POS	52, -27.8	degrees; defaults to ICRS	string
SIZE	0.05	degrees	double
BAND	2.7E-7/0.13	meters	string
TIME	1998-05-21/1999	ISO 8601 UTC	string
FORMAT	votable	-	string

4.1.2 Recommended and Optional Query Parameters

Parameter	Sample value	Unit	Req	Datatype
APERTURE	0.00028 (=1")	degrees	OPT	double
SPECRP	2000	$\lambda/d\lambda$	REC	double
SPATRES	0.05	degrees	REC	double
TIMERES	31536000 (=1yr)	seconds	OPT	double
SNR	5.0	dimensionless	OPT	double
REDSHIFT	1.3/3.0	dimensionless	OPT	string
VARAMPL	0.77	dimensionless	OPT	string
TARGETNAME	mars		OPT	string
TARGETCLASS	star		OPT	string
FLUXCALIB	relative		OPT	string
WAVECALIB	absolute		OPT	string
PUBDID	ADS/col#R5983		REC	string
CREATORID	ivo://auth/col#R1234		REC	string
COLLECTION	SDSS-DR5		REC	string
TOP	20	dimensionless	REC	int
MAXREC	5000		REC	string
MTIME	2005-01-01/2006-01-01	ISO 8601	REC	string
COMPRESS	true		REC	boolean
RUNID			REC	string

The spatial, spectral, and time resolution of the data must all be used as query parameters.

VO-enabled tools

Aladin

VOPlot

TOPCAT

VOSpec

SpecView

SPLAT

ViSiVO (HPC simulations, cosmology)

VOSED

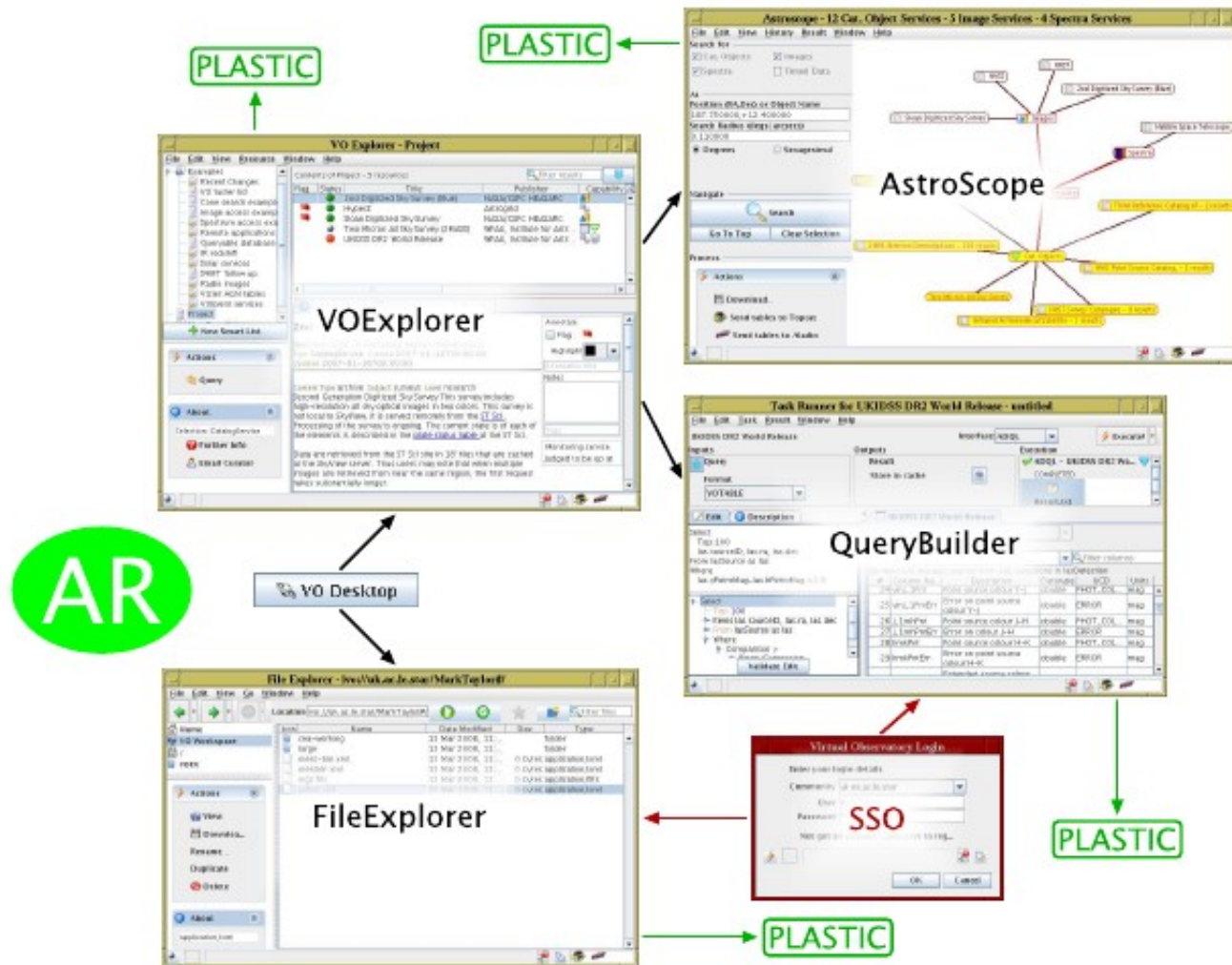
BASTI

SExtractor – WESIX (Web Enabled Source Identification with Cross Matching)

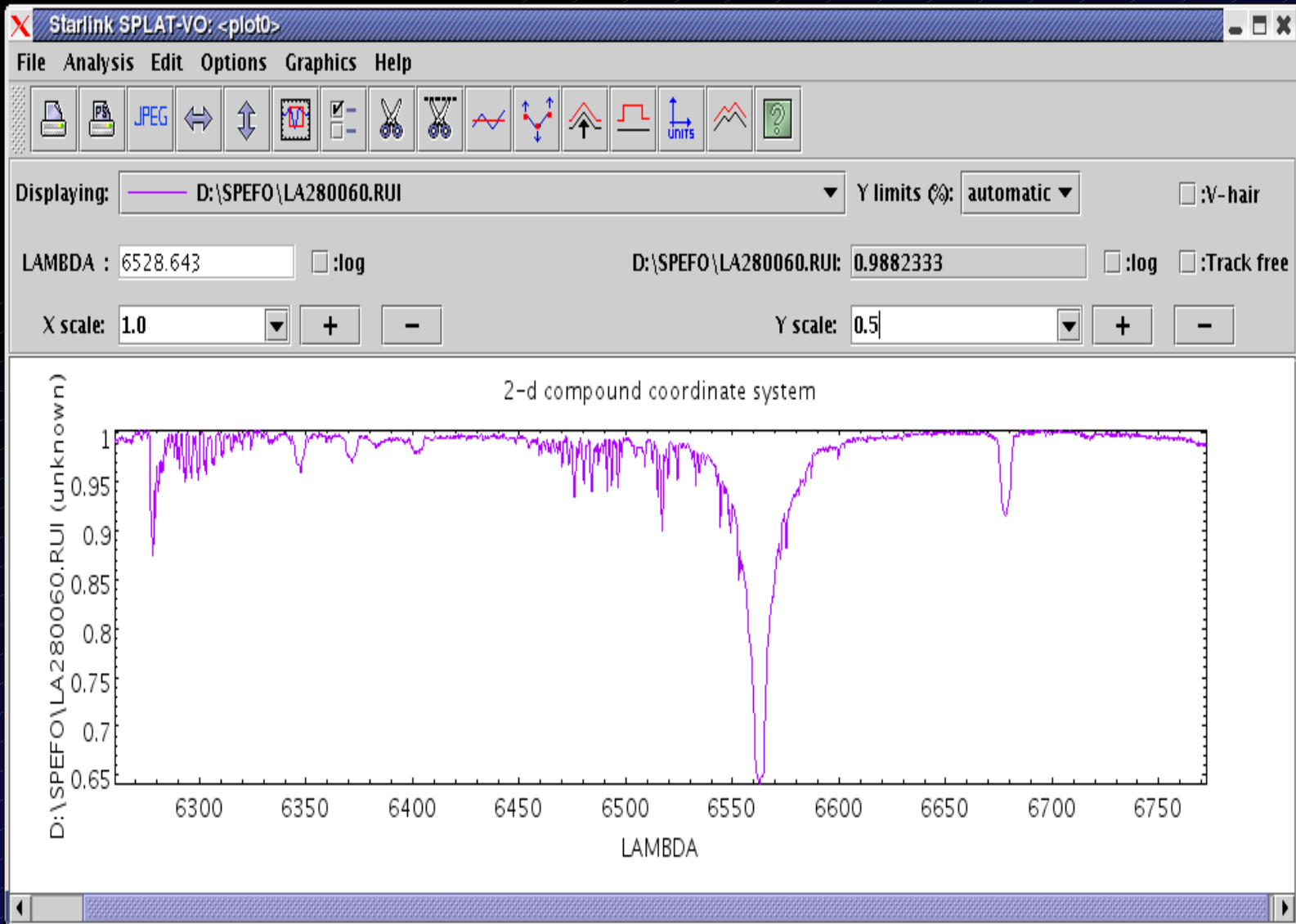
Period04 (since 18.9.08) - PLASTIC

AstroGRID VODesktop

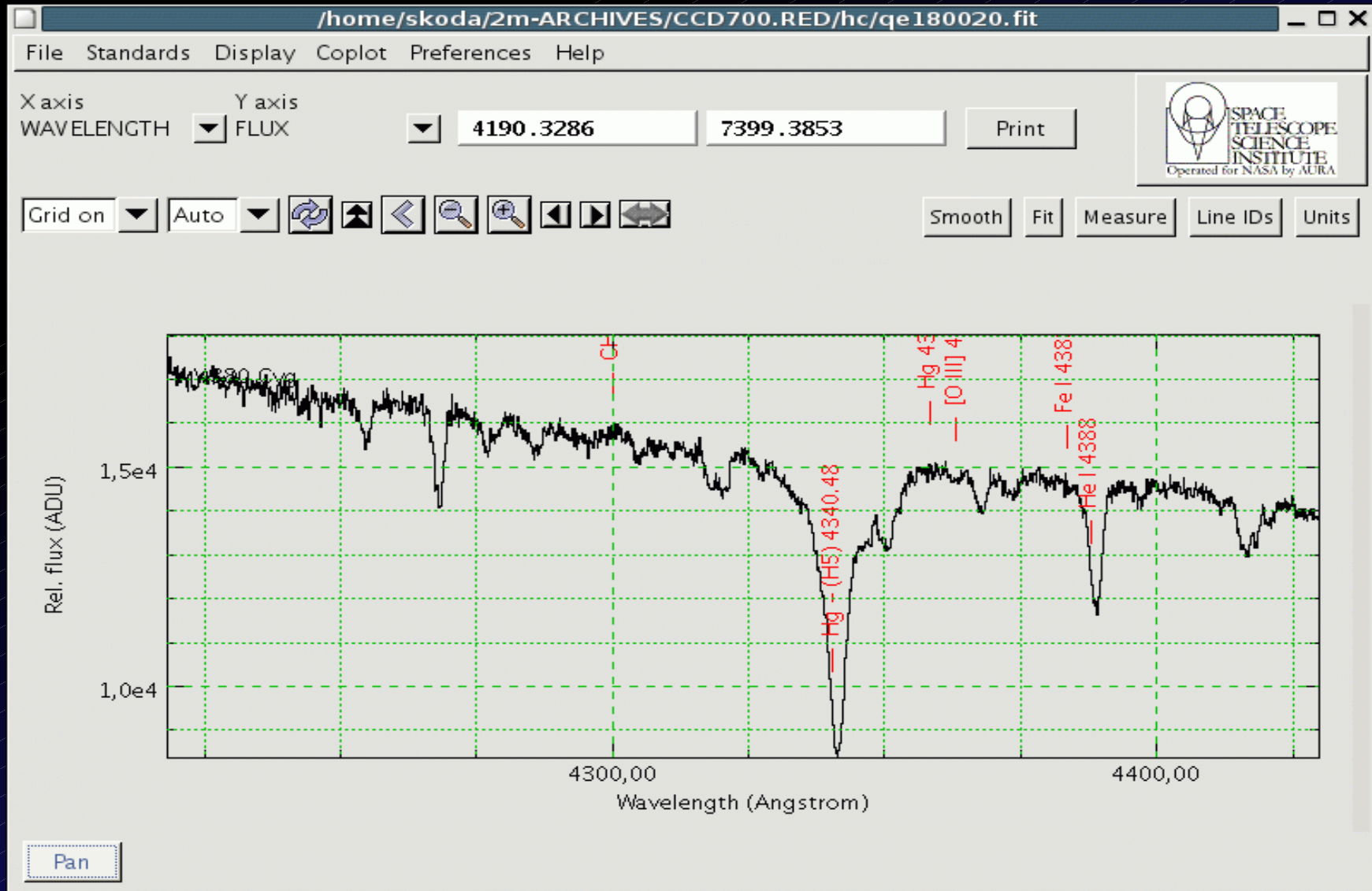
VODesktop Overview



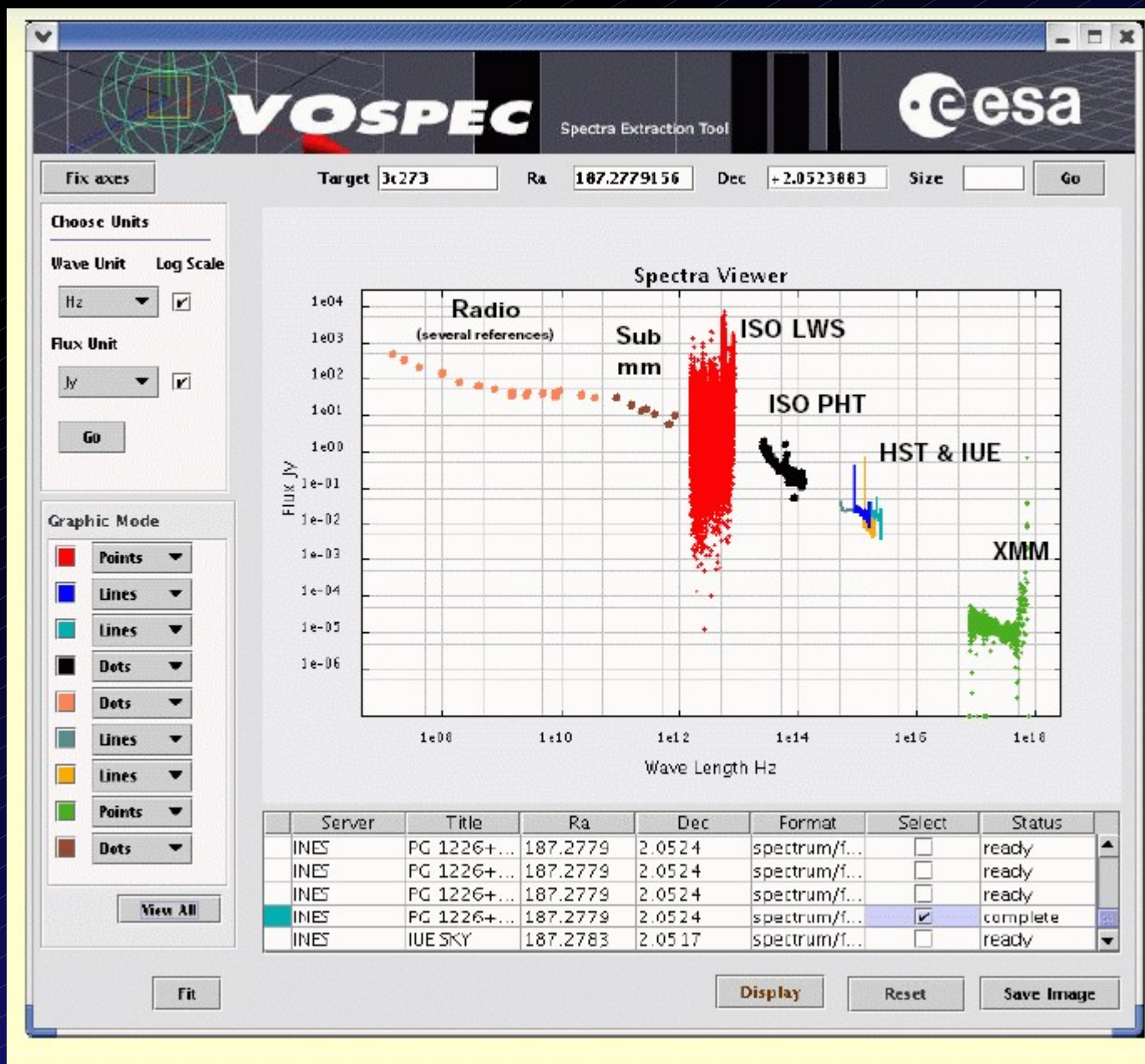
SPLAT-VO (Starlink, JAC)



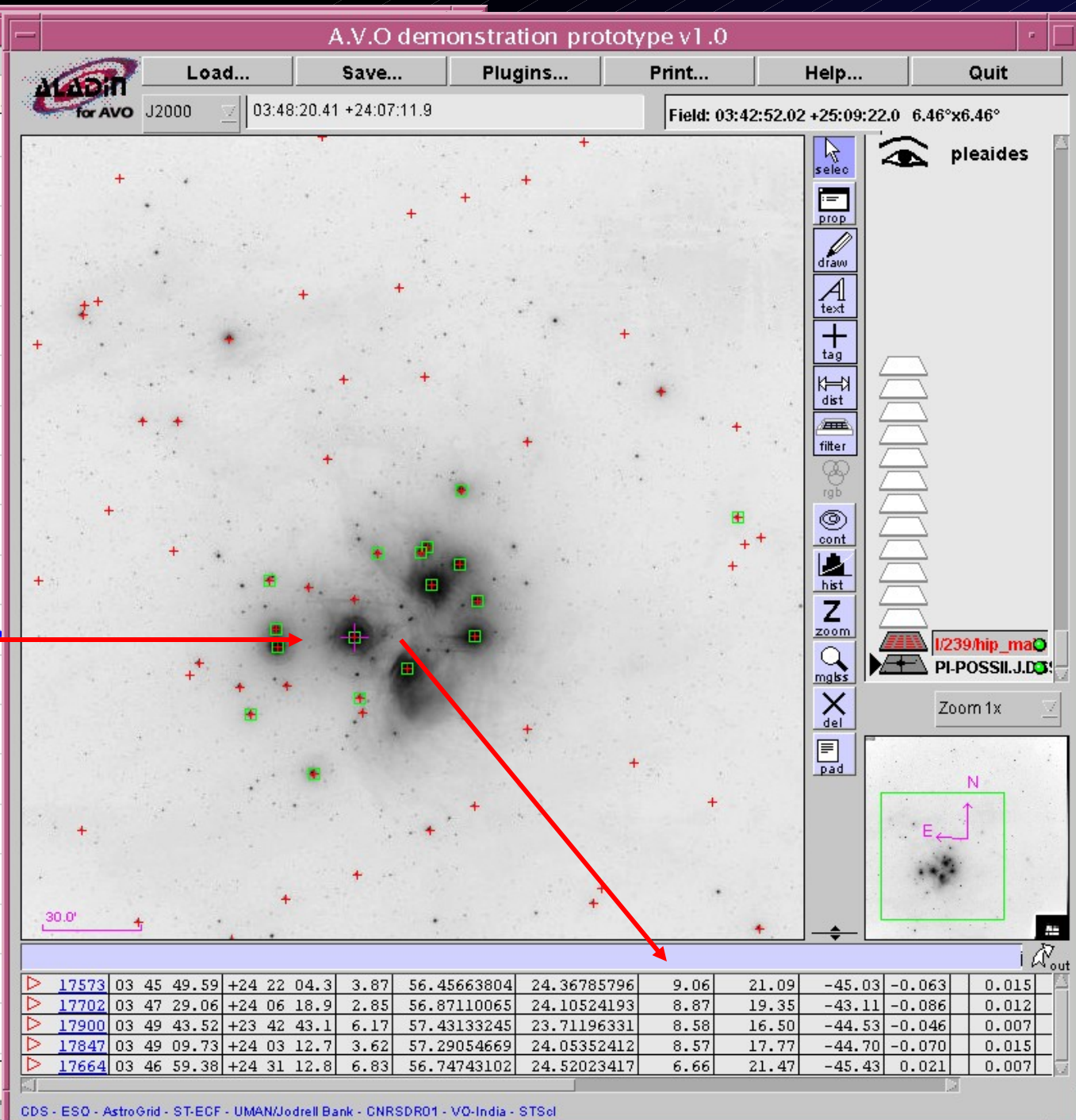
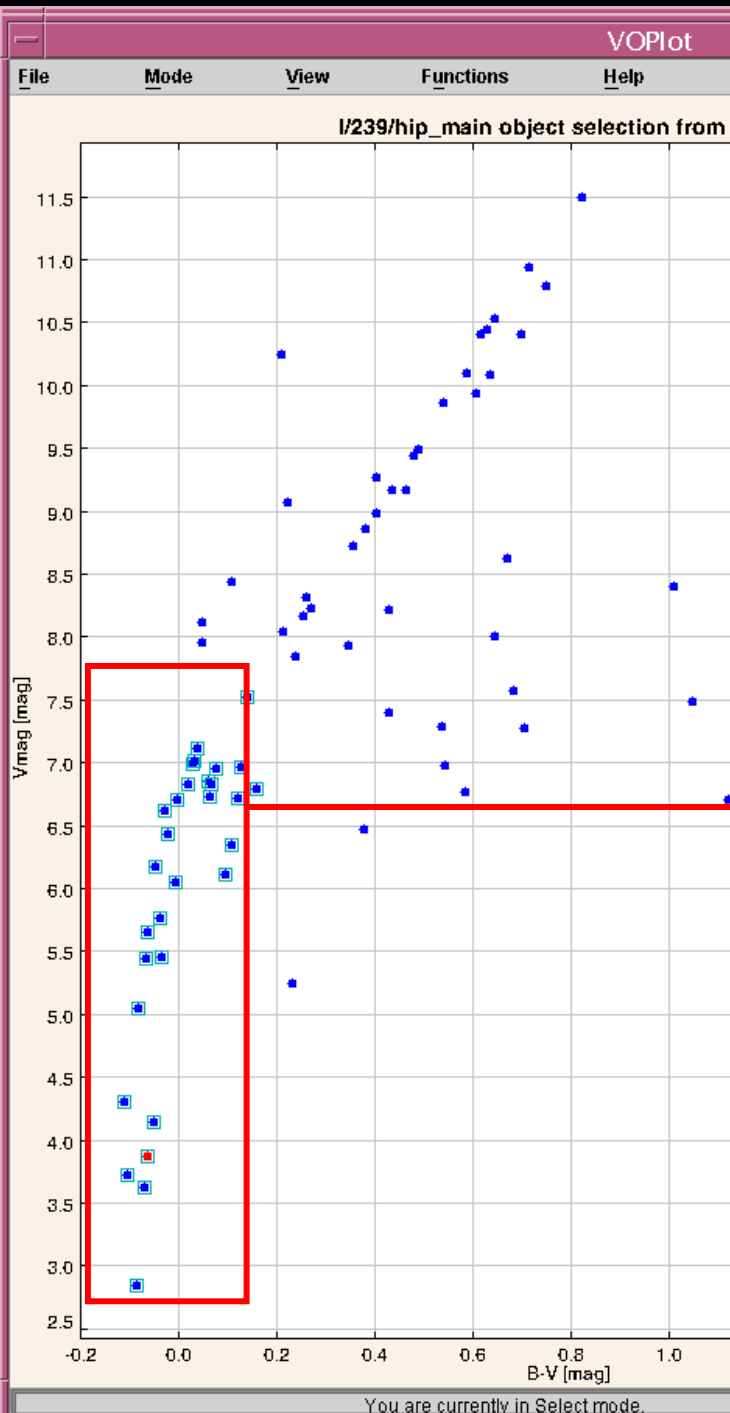
SpecView (STScI)



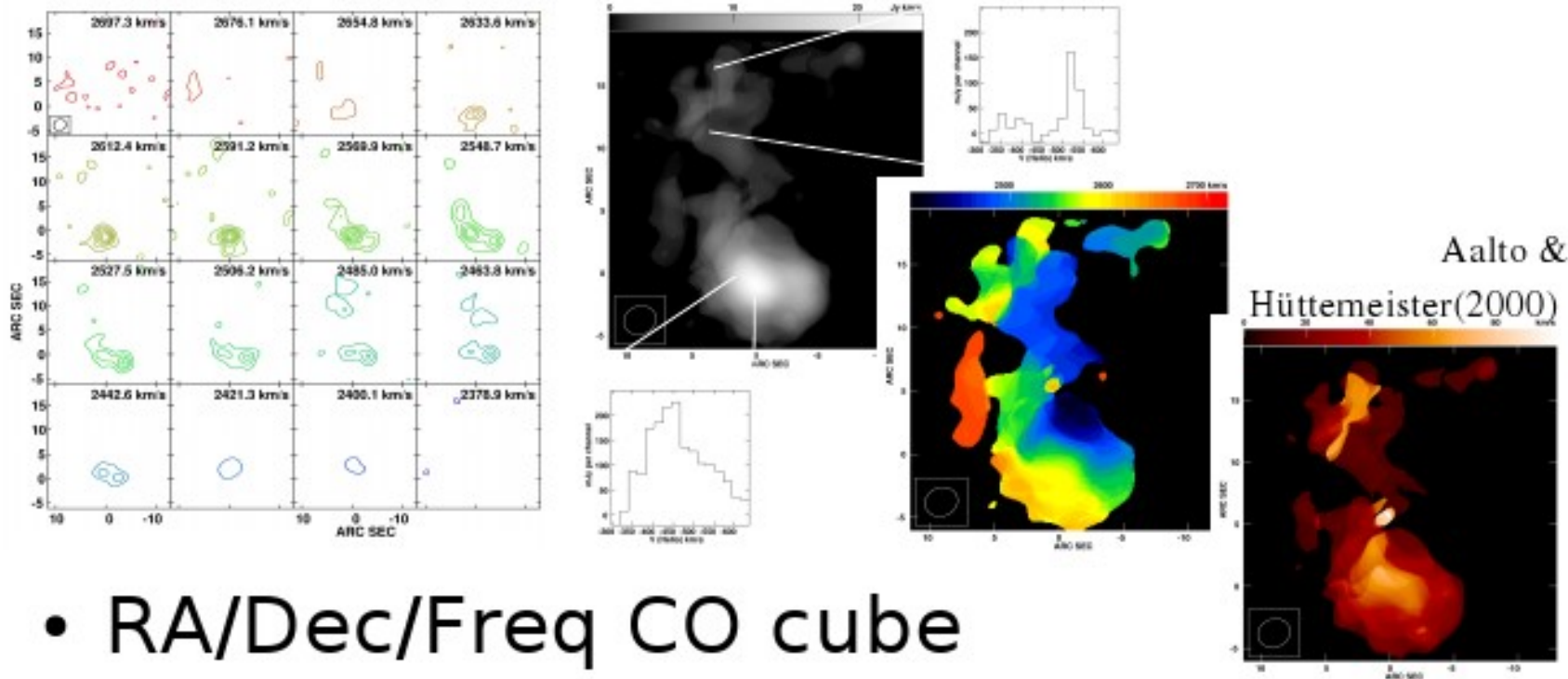
VOSpec (ESAC)



Colour-magnitude diagram



ALMA/IRAM use case



- RA/Dec/Freq CO cube
 - Convert to velocity (LSR, radio convention)
 - Cutouts, simple squashes - VO tools?
 - Smoothed spectra, moments with noise cut-off
 - Specialised server-side pipeline controlled via UWS

Other VOs

Virtual Solar Observatory

Virtual Solar-Terrestrial Observatory

Virtual Magnetospheric Observatory

Virtual Space Physics Observatory

Virtual Meteor Observatory – not proper - XML

SKYBOT – Minor planets ephemerides (1840-2019)

Interest of climatology, meteorology

New branch of Science = **e-Science**

Theory VO (TVO)

- Methods of VO (parameters in DB, SQL...) for study of results of simulations , catalogues of simulated objects like SDSS...(PCA)
- Browsing of simulation space along different axes – parameters, regions...
- Evolutionary tracks, Photo Dissociation Regions
- Formation of artificial galaxies, clusters – N body models (Millenium Run 10 billions, 25TB)
- Theoretical Spectra (GAVO – Rauch, GRID)

CIELO VO - line catalogue SLAP

SLAP Viewer Copyright ESAC, Spain

Server Selector

SLAP Services

- IASD
- LERMA
- NIST ATOMIC SPECTRA
- CIELO SLAP

Molecular line databases

<http://esavo02:8080/cieloslapToolKit/cieloslap.jsp?>

Select

Range of Search (m)

Wavelength Start Wavelength End

Reset

Slap Services Output

CIELO SLAP

Idm:Line_wavelength	Idm:Source...	Source.co...	Source.co...	Idm:Li...	Idm:...	Id...	Id...	Idm:...	I...	...
1.8627e-09	NGC1068	40.66963	-0.01328	1s_3p	1s2	1P1	150	OVII	...	...
1.7768e-09	NGC1068	40.66963	-0.01328	1s_4p	1s2	1P1	150	OVII	...	...
1.89671e-09	NGC1068	40.66963	-0.01328	2p	1s	2...	2...	OVIII	...	...
2.47793e-09	NGC1068	40.66963	-0.01328	2p	1s	2...	2...	NVII	...	...
2.21012e-09	NGC1068	40.66963	-0.01328	1s_2s	1s2	3S1	150	OVII	...	...
2.1602e-09	NGC1068	40.66963	-0.01328	1s_2p	1s2	1P1	150	OVII	...	...
2.18071e-09	NGC1068	40.66963	-0.01328	1s_2p	1s2	3P1	150	OVII	...	...
2.1621e-09	NGC1068	40.66963	-0.01328	1s_2p	1s2	3P1	150	OVII	...	...

Close

VOSpec Spectra Extraction Tool

Target Ra Dec Size Go

Simple Line Access

Wave Unit Log Scale

Flux Unit

RedShift

Go

Graphic Mode

Points

Points

View

Clear Cache Unzoom Display Reset Save Image

Copyright ESAC - Villafranca del Castillo - Madrid, Spain

Wrapper Creator - HowTo - About

VOSpec Spectra Viewer

ISO spectrum of P Cygni

Server	Title	Ra	Dec	Format	Select	Status
Infrared Sp...	ISO SWS01 ...	83.6223	22.0102	spectrum/fits	<input type="checkbox"/>	ready
Infrared Sp...	ISO SWS01 ...	83.63325	22.0346	spectrum/fits	<input type="checkbox"/>	ready
Infrared Sp...	ISO SWS01 ...	83.6402175	22.01457	spectrum/fits	<input checked="" type="checkbox"/>	complete
Infrared Sp...	ISO LWS01 ...	83.633409	22.0346	spectrum/fits	<input type="checkbox"/>	ready
Infrared Sp...	ISO LWS02 ...	83.6334225	22.03459	spectrum/fits	<input type="checkbox"/>	ready

(IVOA Line Data Model: Dubernet, Osuna et al., in preparation)
(Simple Line Access Protocol: Salgado et al., in preparation)

VO for Atomic and Molecular Data

VAMDC (06/2009-12/2012 FP7)

13 organizations

Virtual Atomic and Molecular Data Centre

VO principles (web services, integration, registry,
SAMP, VODesktop, TOPCAT, VOSpec)

(includes VALD extractor, NIST)

extended citation system (all providers acknowledged)

Access protocols in VO: TSAP

Theoretical models in the VO

- **Theoretical spectra: TSAP**

- Included in the SSAP standard (use case for theoretical spectra)
- A simple protocol.
- Dialog server-application.

Theoretical model services Documents Models Services

SVO Spanish Virtual Observatory

TSAP interface
An interface to test TSAP services

Funded by INTA
MINISTERIO DE CIENCIA E INNOVACIÓN

Services: VOSA Filters TSAP S3if esm@laeff.inta.es Uploads LogOut

TSAP Interface

SVO Theoretical Data Access Service: ATLAS9 Kurucz ODFNEW/NOVER models (Castelli et al., 1997, AA, 318, 841)

teff_min:	<input type="text" value="3500"/>	(min value for the effective temperature for the model. Temperatures are given in K)
teff_max:	<input type="text" value="3500"/>	(max value for the effective temperature for the model. Temperatures are given in K)
logg_min:	<input type="text" value="0.00"/>	(min value for Log(G) for the model.)
logg_max:	<input type="text" value="0.00"/>	(max value for Log(G) for the model.)
meta_min:	<input type="text" value="-2.50"/>	(min value for the Metallicity for the model.)
meta_max:	<input type="text" value="-2.50"/>	(max value for the Metallicity for the model.)

[See metadata VOTable](#)

VOSpec - models by TSAP

Server Selector

Query by Service

Green services support params selected

- The ISO Data Archive InterOperability System
- VVDS-F02 DEEP spectra
- Wisconsin Halfwave Spectropolarimeter
- Wisconsin Ultraviolet Photo-Polarimeter Experiment
- cutout server of HEROS archive of Ondrejov observations

Theoretical Spectra Services

- PGos3: Evolutionary synthesis models
- PGos3: X-ray service prototype
- PGos3:VO-Mexico Model:Sternberg
- PGos3:VO-Mexico Model:UCL
- SVO: ATLAS9 Kurucz ODFNEW/NOVER models (Castelli et al.)
- SVO: Coelho Synthetic stellar library
- SVO: Models of irradiated accretion disks around PMS stars (D' Alessio et al.)
- SVO: PopStar evolutionary synthesis model
- TMAP SSA service
- VO-Paris: PEGASE.HR synthetic spectra

Query Outlook

Add SSA/TSA locally Select All

<http://archive.eso.org/apps/ssaserver/EsoProxySsap?&POS=304.44667416667,38.03293027778>

<http://archive.eso.org/apps/ssaserver/EsoProxySsap?&POS=304.44667416667,38.03293027778>

<http://archive.stsci.edu/ssap/search.php?id=HST&&POS=304.44667416667,38.03293027778>

<http://archive.eso.org/apps/ssaserver/EsoProxySsap?&POS=304.44667416667,38.03293027778>

Query by params

Tree

Query

- TARGET.NAME p cyg
- Simple Query
 - POS 304.44667416667,38.03293027778
 - SIZE 0.1
- Advanced Query
- Service Specific Query
 - PGos3: Evolutionary synthesis models
 - PGos3: X-ray service prototype
 - PGos3:VO-Mexico Model:Sternberg
 - PGos3:VO-Mexico Model:UCL
 - SVO: ATLAS9 Kurucz ODFNEW/NOVER models (Castelli et al.)
 - SVO: Coelho Synthetic stellar library
 - SVO: Models of irradiated accretion disks around PMS stars (D' Alessio et al.)
 - SVO: PopStar evolutionary synthesis model
 - TMAP SSA service
 - VO-Paris: PEGASE.HR synthetic spectra

Insert Param Value

Point mouse on param label to see description

n

Add

Query Reset

esa VO Virtual Observatory

Interop Help

HD 141569 Ra 37.49062042 Dec -3.92121111 Size 0.1 Query

VOSpec Spectral Analysis Tool

Wavelength (micron, logarithmic)

Kurucz ODFNEW /NOVER, teff:10000, logg:4.00, meta:-0.50

SVO: Models of irradiated accretion disks around PMS stars (D' Alessio et al.) dalessio, teff=4000

Retrieve Reset

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Kurucz stellar model and D'Alessio model of PMS discs fit to UV and IR spectra of HD 141569

Archives, Theory, VO-Science, DataMining, E&O

Simple Spectral Access Protocol V1.04


Appendix A: Theoretical Spectral Access Use Case

The image displays the VOSpec interface, which is used for accessing and viewing theoretical spectra. It consists of several main components:

- Server Selector:** A panel on the left that allows users to query services. It lists various services under "Theoretical Spectra Services", with "PGos3: Evolutionary synthesis models" selected. A "Query Outlook" section at the bottom shows the URL for the selected service: `http://ov.inaep.mx/taap/SyntMod.php?`.
- VOSpec Main Window:** The central window displays the "VOSpec Spectra Viewer". It shows a plot of Flux (Jy, logarithmic) versus Wavelength (micron, logarithmic). The plot includes data points from various sources: HST (MAST), 2MASS photometry, Kurucz Models (SVO), INES (SVO), and ISO (ESA-VO). The plot is overlaid with a yellow grid.
- Target Information:** The top right of the VOSpec window shows the target name "Vega", its coordinates (Ra: 279.2347350, Dec: +38.7836919), and a size of .1. A "Go" button is provided to refresh the data.
- Graphic Mode:** A panel on the left of the plot allows users to choose the display mode for different data series, such as "Points" or "Lines" in various colors.
- Spectra List:** A list at the bottom of the VOSpec window shows the selected spectrum: "IUE/INES Spectrum: LWR04154HS, Target: HD 172167". Other spectra in the list are for "LWR04154RS" and "LWR07008RS".

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- Other VO Data Centres providing theoretical spectra using TSAP



GERMAN ASTROPHYSICAL
GAVO
VIRTUAL OBSERVATORY

German Astrophysical Virtual Observatory

Archive: **TMAP Spectra**

Effective temperature in K: +/-

Surface gravity (log g) in cm/s²: +/-

Mass fraction 0: +/- dex

Mass fraction 1: +/- dex

Mass fraction 2: +/- dex

Mass fraction 3: +/- dex

Mass fraction 4: +/- dex

Mass fraction 5: +/- dex

Mass fraction 6: +/- dex

Mass fraction 7: +/- dex

Band: The wavelength range in format "wavelength₁/wavelength₂" in the selected unit.

Data format: Format of the individual spectra. (No need to select, if return format is html.)

Return Format: votable html The format in which to present the metadata. (If html is selected, no further selection of data format is necessary, since links to all available formats will be created anyways.)

[More information on archive](#)

- PGos3 (Mexico), PEGASE (VO-Paris)

BaSTI database



Micro-simulations inside the VO: the BaSTI case



P. Manzato⁽¹⁾, M. Molinaro⁽¹⁾, F. Gasparo⁽¹⁾, F. Pasian⁽¹⁾, A. Pietrinferni⁽²⁾, S. Cassisi⁽²⁾, C. Rodrigo⁽³⁾, M. Cerviño⁽⁴⁾, E. Solano⁽³⁾
INAF - SI / Trieste Astronomical Observatory; (2) INAF - Teramo Astronomical Observatory; (3) LAEFF-INTA / Spanish VO; (4) Instituto de Astrofísica de Andalucía - CSIC / Spanish VO

S3P (Simple Self-Described Service Protocol) implementations

In collaboration with SVO (the Spanish Virtual Observatory) we presented S3P in the last IVOA Interoperability Meeting. S3P (Simple, Self-described Service) is a protocol oriented to handle theoretical data in the VO framework. It is based in the ability of the data server to describe itself in a simple standardized way.

This is a step by step protocol:

1 step: the service described it self (input and output parameters);

<http://myservice.com/s3.php?format=metadata>

2 step: http query and response in VOTable format;

<http://myservice.com/s3.php?param1=value1¶m2=value2...>

3 step: retrieve the simulated files of interest via http GET;

<http://myservice.com/s3.php?id=12>

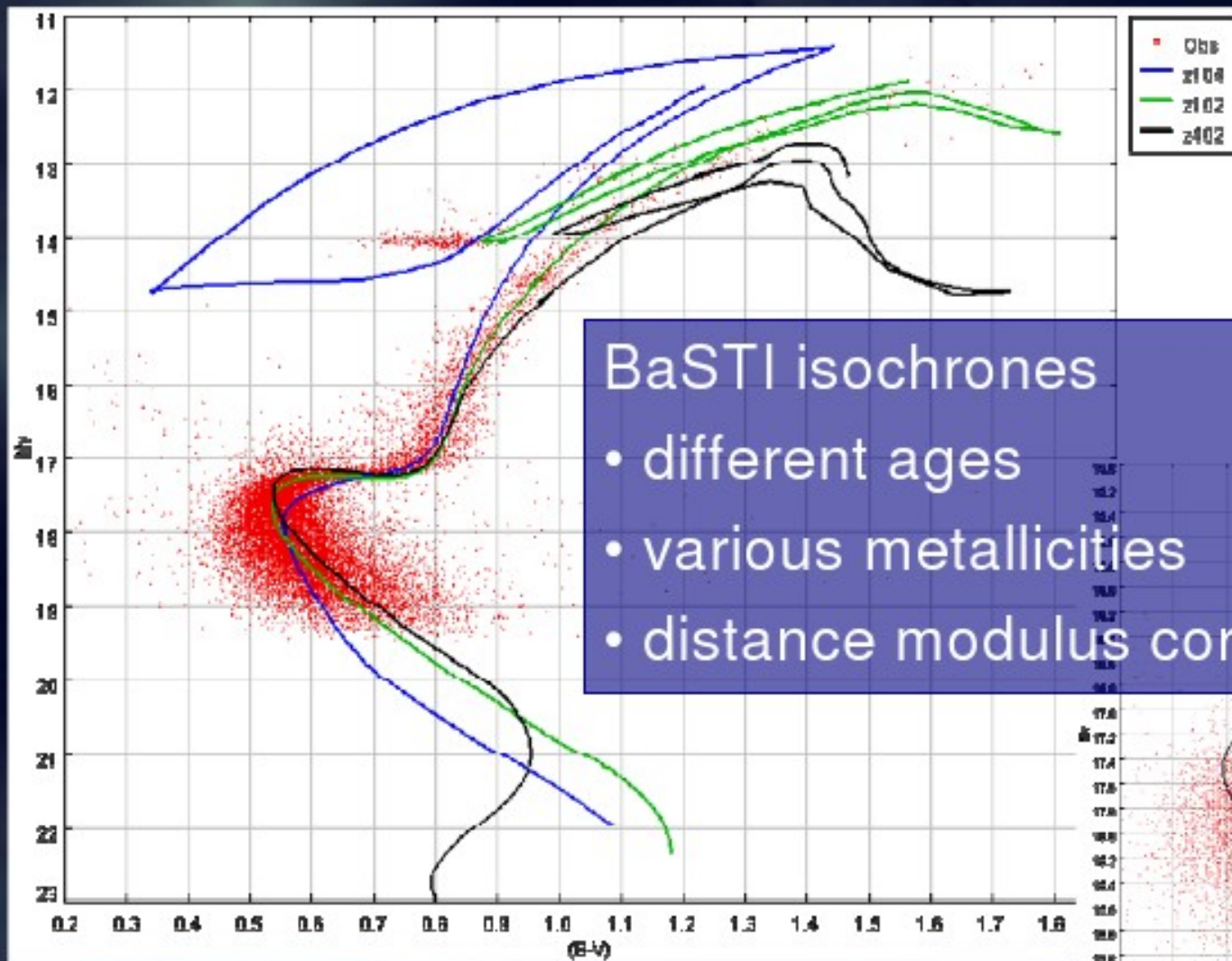
We developed two prototype implementations of S3P for BaSTI: one for isochrones and one for tracks:

<http://albione.oa-teramo.inaf.it/PHPmetadata/BaSTIisochron.php?format=metadata>

<http://albione.oa-teramo.inaf.it/PHPmetadata/BaSTItrack.php?format=metadata>

Param	UCD	Description
INPUT:age_min	time.age	Min. age of the isochron in Gyr (min value 0.03 Gyr)
INPUT:age_max	time.age	Max. age of the isochron in Gyr (max value 19 Gyr)
INPUT:meta_min	phys.abund.Z	Min. mass fraction of the initial heavy elements abundance for stellar isochron model (min value 0.0001)
INPUT:meta_max	phys.abund.Z	Max. mass fraction of the initial heavy elements abundance for stellar isochron model (max value 0.4)
OUTPUT:age	time.age	value for the stellar Age for the model. Age is given in Gyr
OUTPUT:meta	phys.abund.Z	value of mass fraction of the initial heavy elements abundance for the model.
OUTPUT:[MH]	phys.abund.Z	The metal abundance in the spectroscopic formalism.
OUTPUT:[FeH]	phys.abund.Fe	The iron abundance in the spectroscopic formalism.
OUTPUT:Y	phys.abund.Y	value of mass fraction of the initial helium abundance. Actually calculated as $Y = 1.44 * (Z - 0.0001)$.
OUTPUT:MassLoss	phys.mass.loss	value of mass loss according to the Reimers (1975) law.
OUTPUT:title	VOX.image_title	Title.

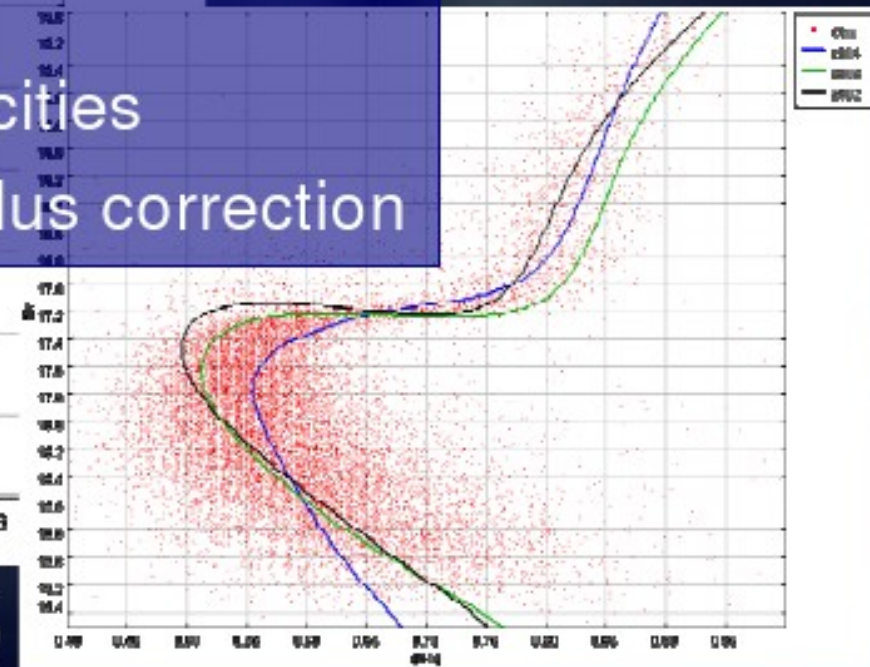
BaSTI Isochrones



step 1
metallicity

BaSTI isochrones

- different ages
- various metallicities
- distance modulus correction



$z = 0.01$ (α -enh) ; 0.008 (scaled solar)

Archives, Theory, VO-Science, DataMining, E&O

Theoretical model services



VOSA: VO Sed Analyzer

VO SED Analyzer

Services: VOSA Filters TSAP S3if

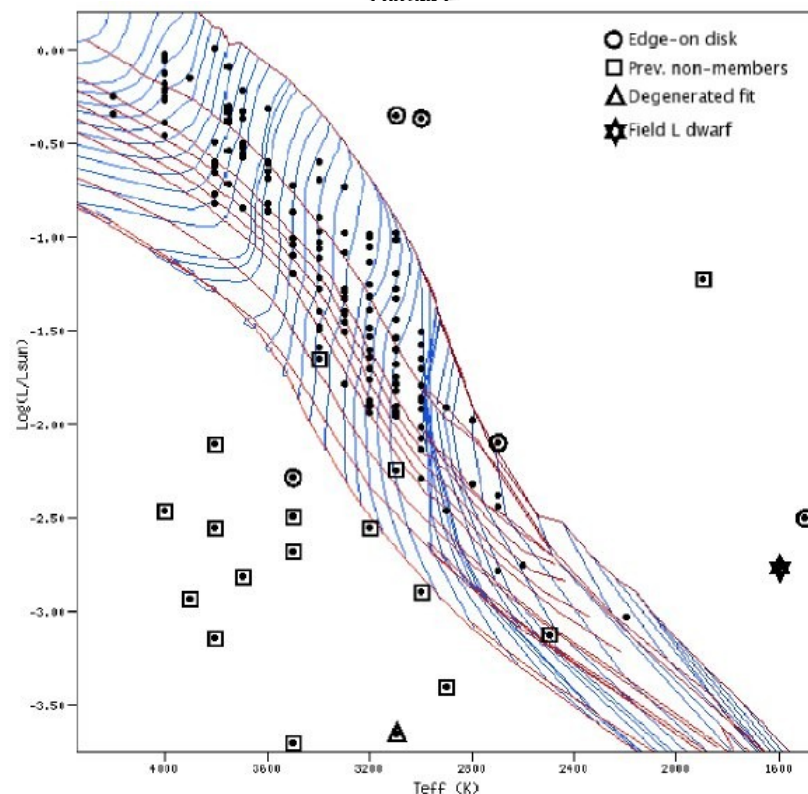
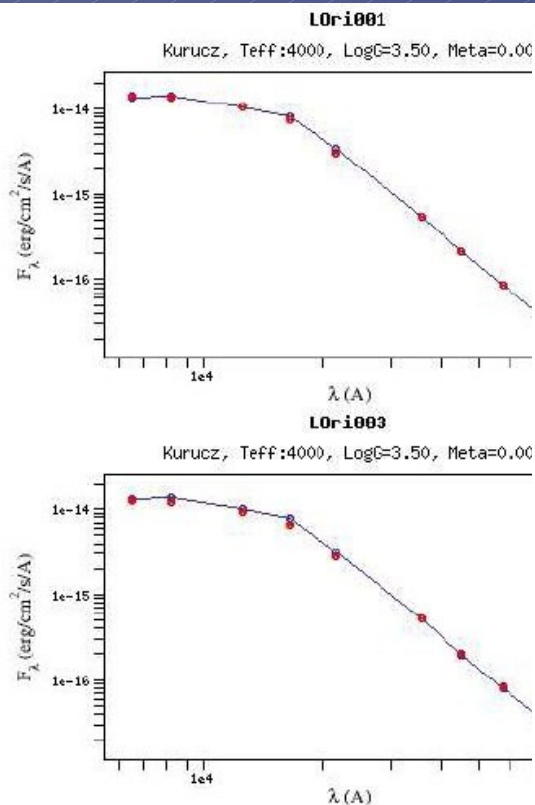
Astronomy & Astrophysics manuscript no. Synth 'VO-PR1' ref format
August 2, 2008

VOSA: Virtual Observatory SED Analyzer.

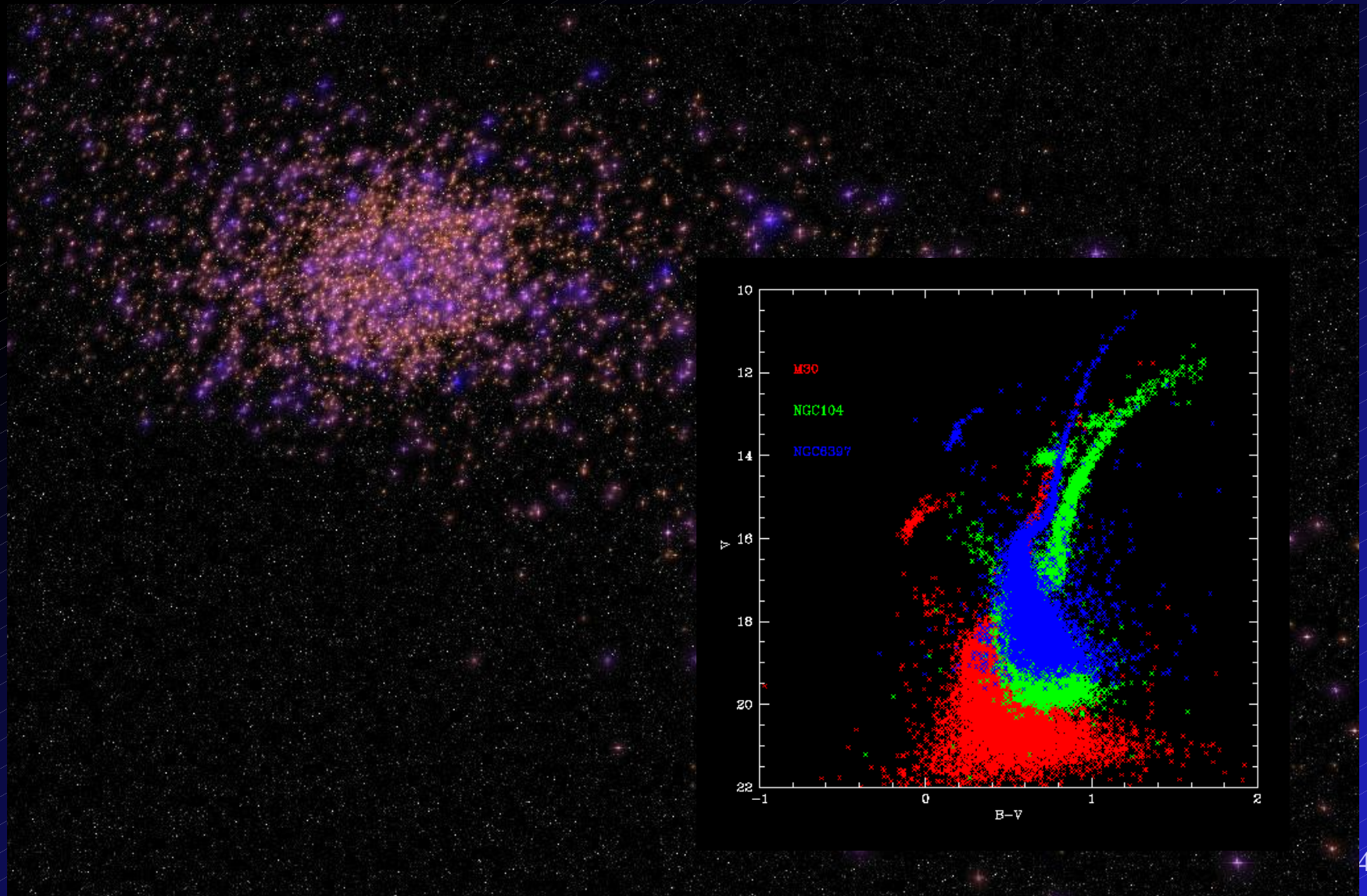
An application to the Collinder 69 open cluster

A. Bayo^{1,2}, C. Rodrigo^{1,2}, D. Barrado y Navascués^{1,2}, E. Solano^{1,2}, R. Gutiérrez^{1,2}, M.

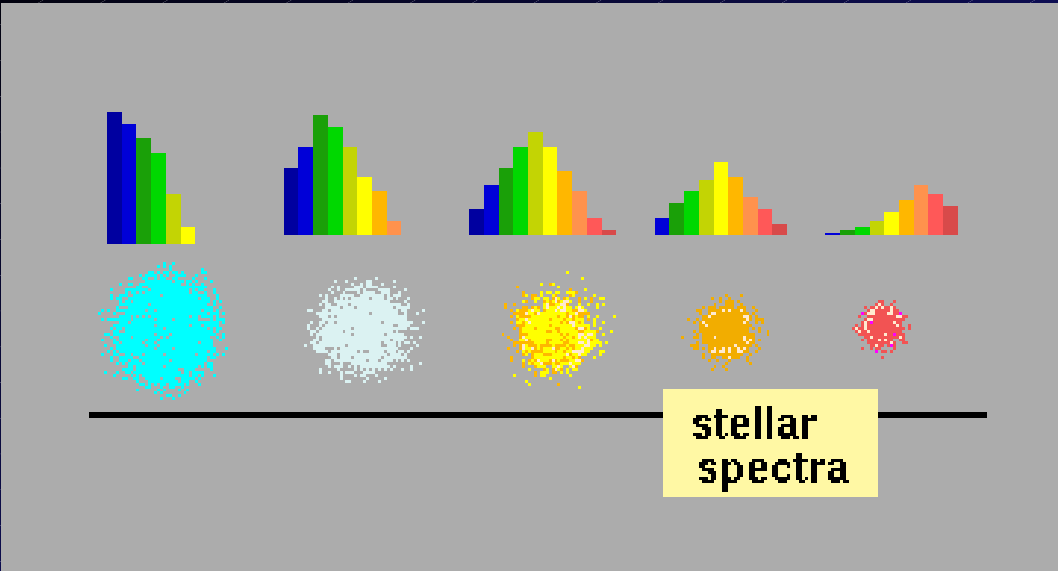
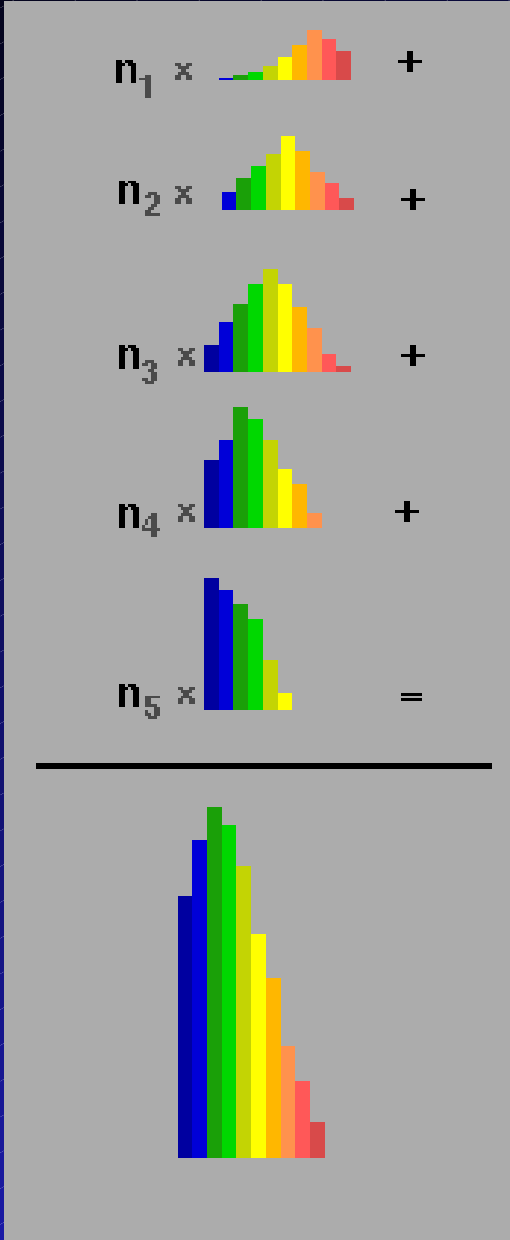
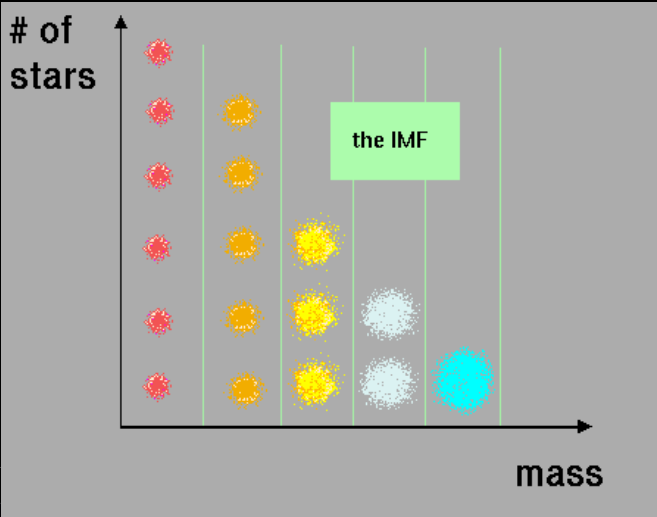
Object	Model	T _{eff}	LogG	Metallicity	χ ²
LO#001	Kurucz	4000	3.50	0.00	1.71e
LO#002	NextGen	3800	4.5	0	1.44e
LO#003	Kurucz	4000	3.50	0.00	5.05e
LO#004	Kurucz	3750	4.00	0.00	2.82e
LO#005	NextGen	4000	4.0	0	3.26e
LO#006	Kurucz	4000	3.50	0.00	3.36e
LO#007	Kurucz	4000	4.50	0.00	2.49e
LO#008	Kurucz	4000	3.50	0.00	4.43e
LO#009	NextGen	4000	3.5	0	6.22e
LO#010	NextGen	4200	4.0	0	1.87e
LO#011	NextGen	3900	4.5	0	1.20e
LO#012	NextGen	4000	4.5	0	6.58e
LO#013	NextGen	3700	4.5	0	3.50e
LO#014	Kurucz	4000	4.50	0.00	4.70e
LO#015	Kurucz	4000	3.50	0.00	3.73e
LO#016	Kurucz	3750	4.50	0.00	5.53e
LO#017	NextGen	4200	4.0	0	7.58e
LO#018	Kurucz	3750	3.50	0.00	4.31e
LO#019	Kurucz	3750	3.50	0.00	1.90e
LO#020	NextGen	3800	4.5	0	2.98e
LO#021	Kurucz	4000	3.50	0.00	3.08e
LO#022	Kurucz	3750	4.00	0.00	1.76e
LO#023	NextGen	4000	4.5	0	2.35e
LO#024	Kurucz	3750	3.50	0.00	2.22e
LO#025	NextGen	3700	4.5	0	1.37e
LO#026	NextGen	3700	4.5	0	4.81e
LO#027	NextGen	4000	4.5	0	2.35e
LO#028	Kurucz	3750	4.00	0.00	1.28e
LO#029	NextGen	3100	4.5	0	7.28e
LO#030	NextGen	3700	4.5	0	2.15e
LO#031	NextGen	3800	4.5	0	2.77e
LO#032	NextGen	3700	4.5	0	1.70e
LO#033	NextGen	3700	4.5	0	7.12e
LO#034	NextGen	3000	4.0	0	1.77e
LO#035	NextGen	3700	4.5	0	1.61e



N Body Simulations of Globular Cluster Evolution



Stellar populations are modeled with synthesis models



Using SimDB/SimDAP

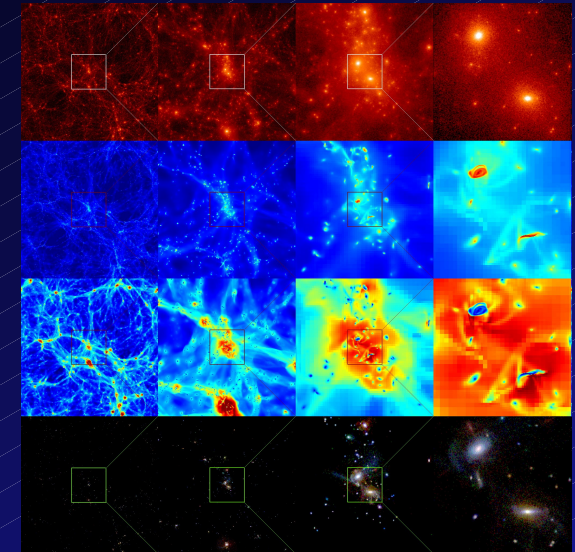
- Cosmological simulations
 - Prototypes for GalMER, Horizon
- PDR simulations
 - test implementation of Meudon PDR code
- Isochrones/evolutionary tracks
 - BaTSI
- Visualization tools
 - VisIVO

GalMer

DB Query | Query Results | Experiment | Snapshot | Description

Select Input Parameters

Galaxy #1	Galaxy #2	Query	
gE0 ▲ gSa ▲ gSb ▲ gSd ▼	gE0 ▲ gSa ▲ gSb ▲ gSd ▼	Orbit type	1 ▼
		Spin	Prograde ▼
		Inclination	0 deg ▼



Virgo - Millennium Database

Documentation

CREDITS/Acknowledgments

Registration

News

Databases
millimil (context)

Check out the latest news about the release of the Millennium-II database.

Streaming queries return unlimited number of rows in CSV format and are cancelled after 30 seconds.
Browser queries return maximum of 1000 rows in HTML format and are cancelled after 30 seconds.

Query (stream)

Query (browser)

Help

Maximum number of rows to return to the query form: 10 ▼

GADGET-2: Galaxies with dark matter and gas interact

A code for cosmological simulations of structure formation



Millennium Run

10^{10} particles

Several Gpc to

10 kpc

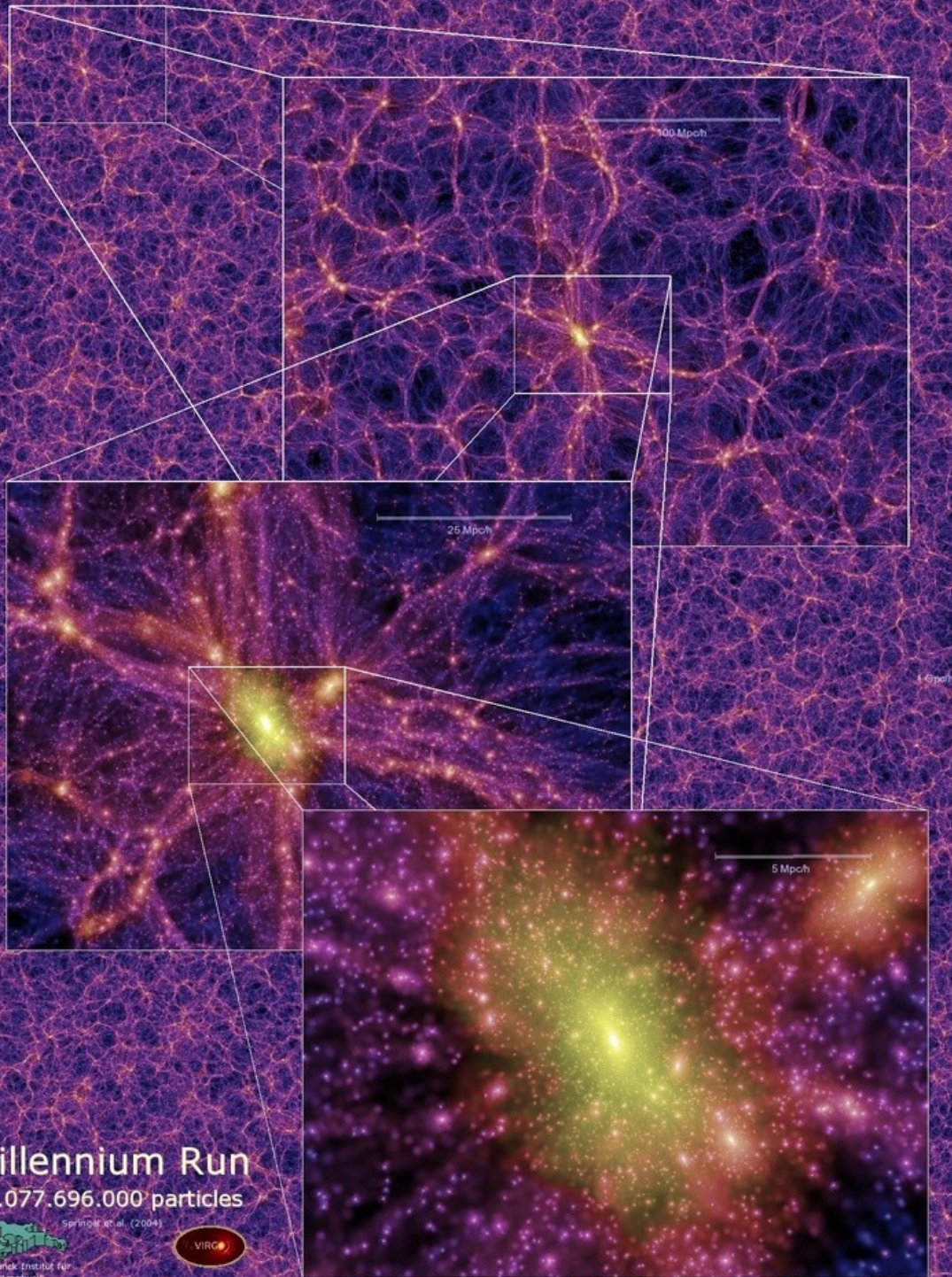
Cube 2 billion ly

One month MPSSC

25 TB

Evolution of 20 mil
galaxies

Evolution merger tree



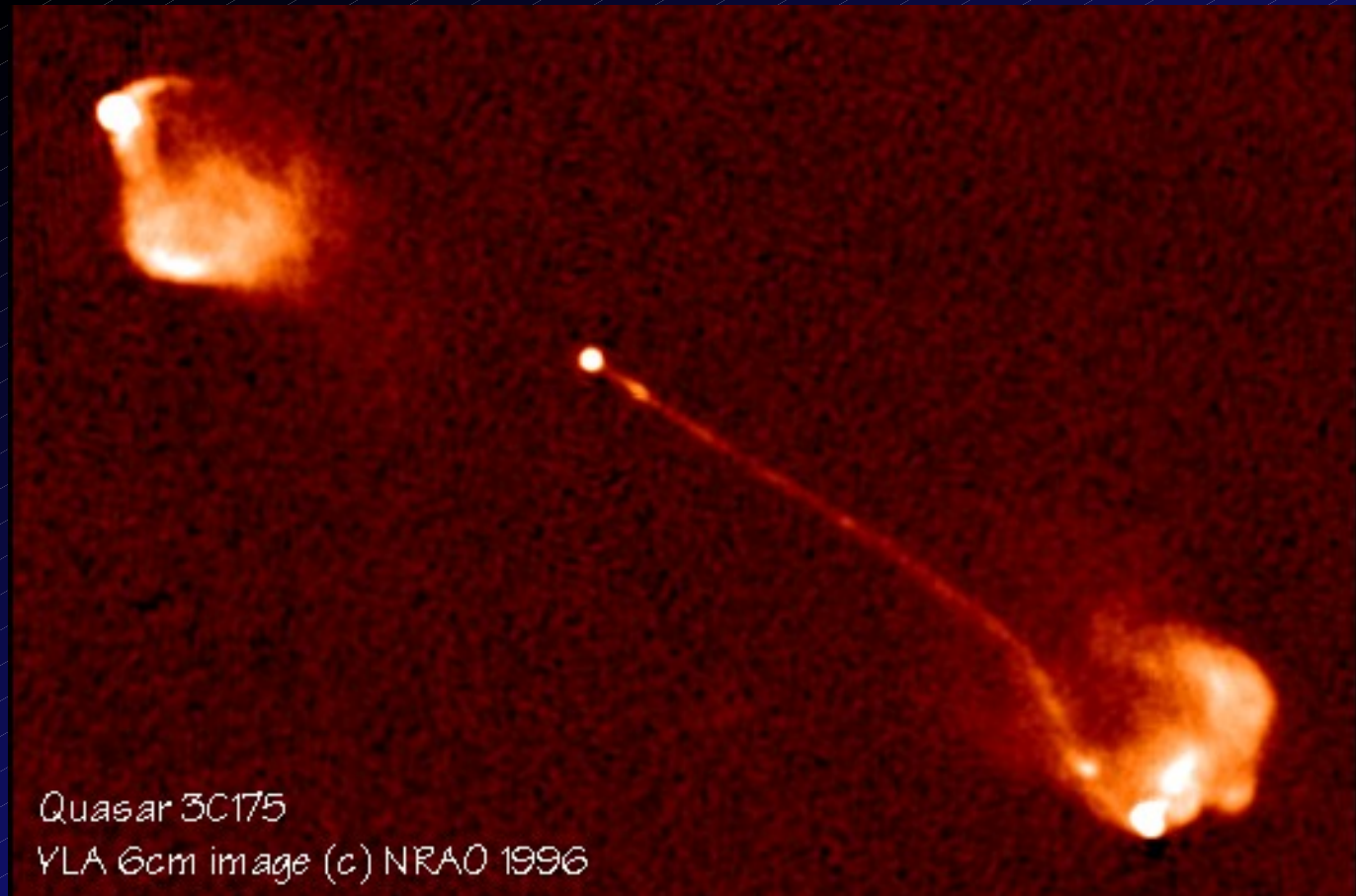
Millennium Run
10,077,696,000 particles

Spring et al. (2004)
Max-Planck-Institut für
Astrophysik

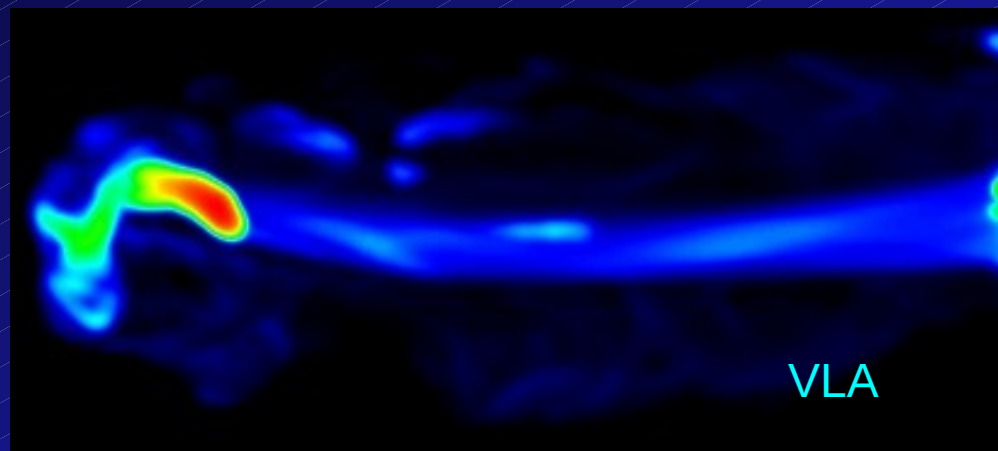
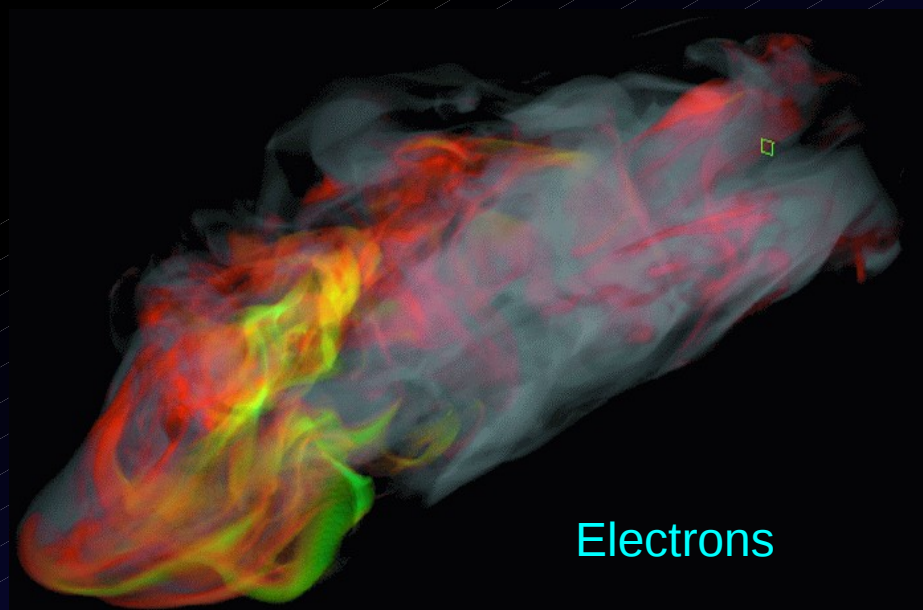


Collimated Outflows from AGN

- 3C 175

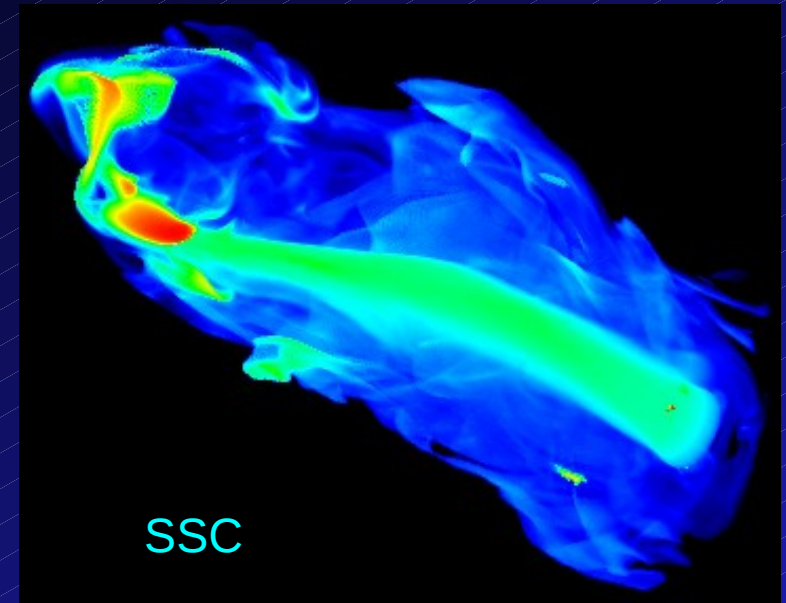
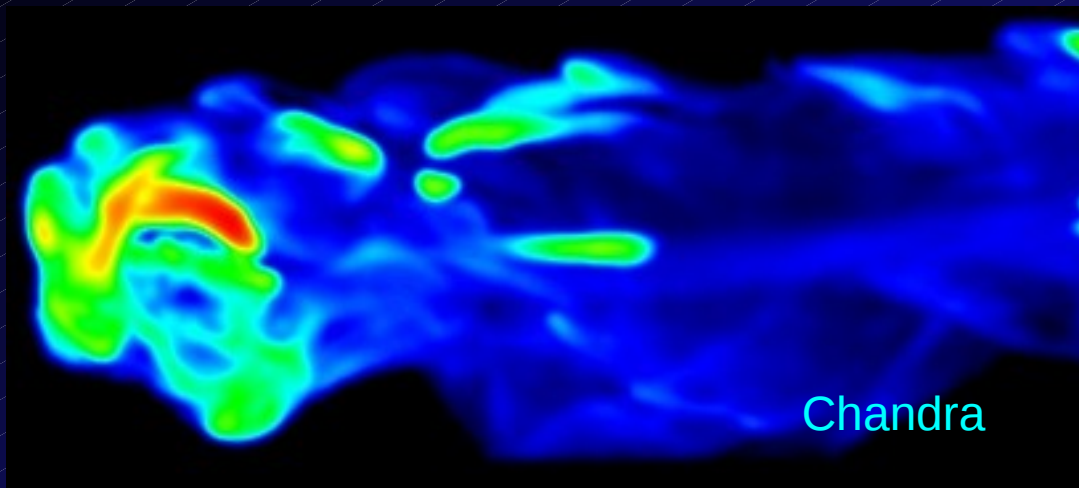
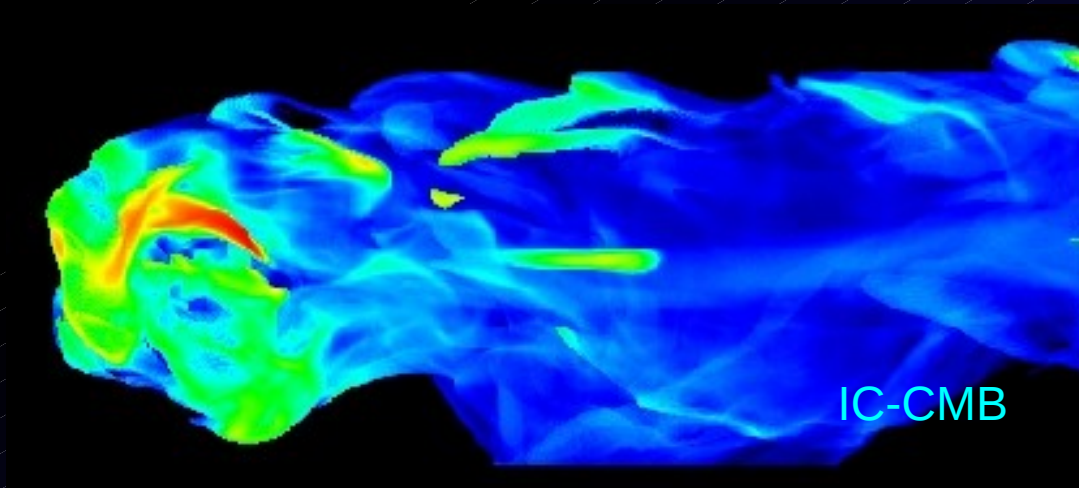


MHD Simulations of Collimated Outflows from AGN - Virtual Telescope Observations



Compare with
Radio
Archives

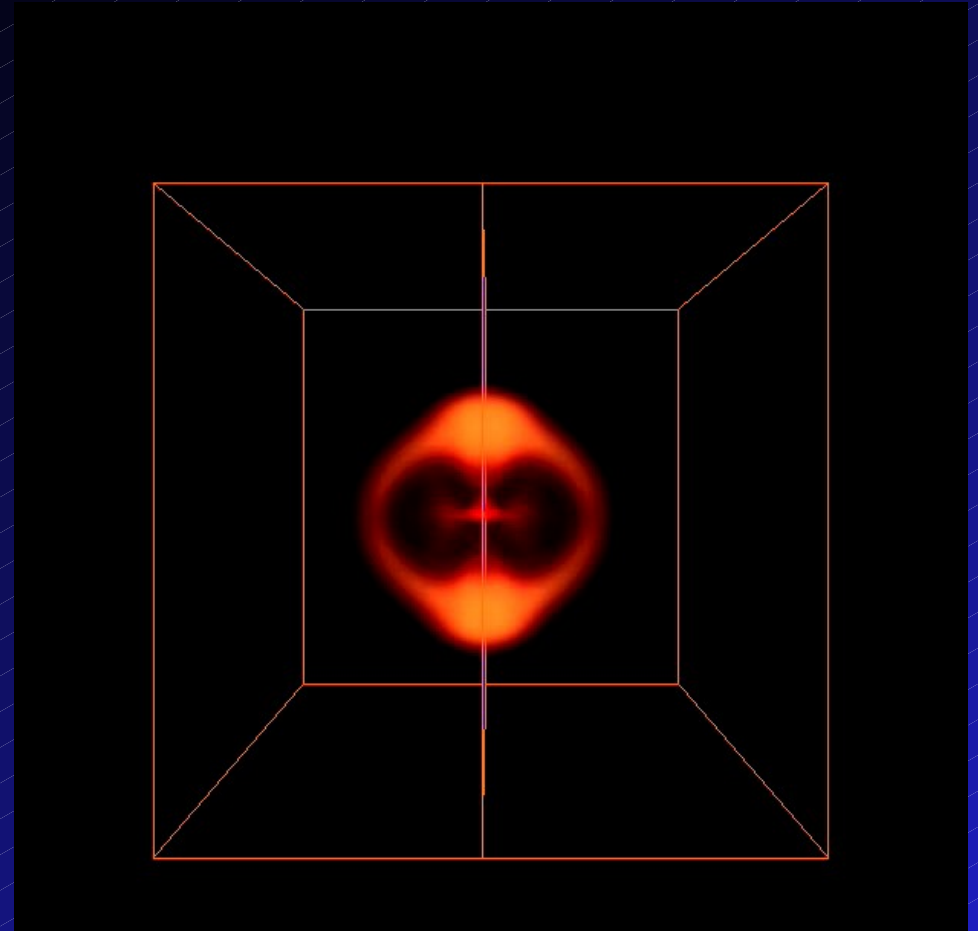
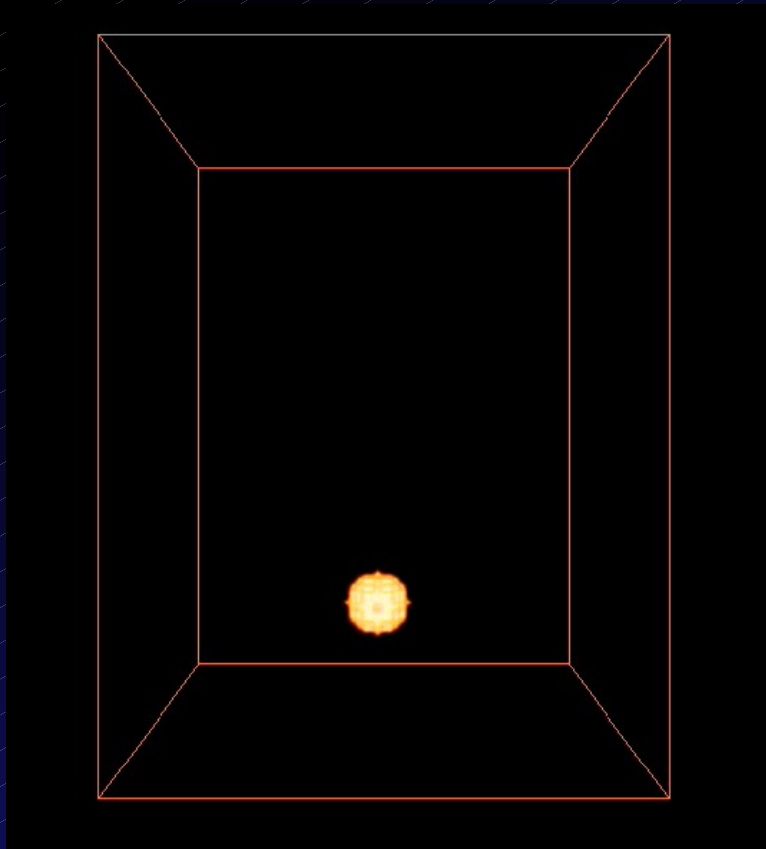
MHD Simulations of Collimated Outflows from AGN - Virtual Telescope Observations



Compare with
Chandra Archives

Three Dimensional MHD Calculations

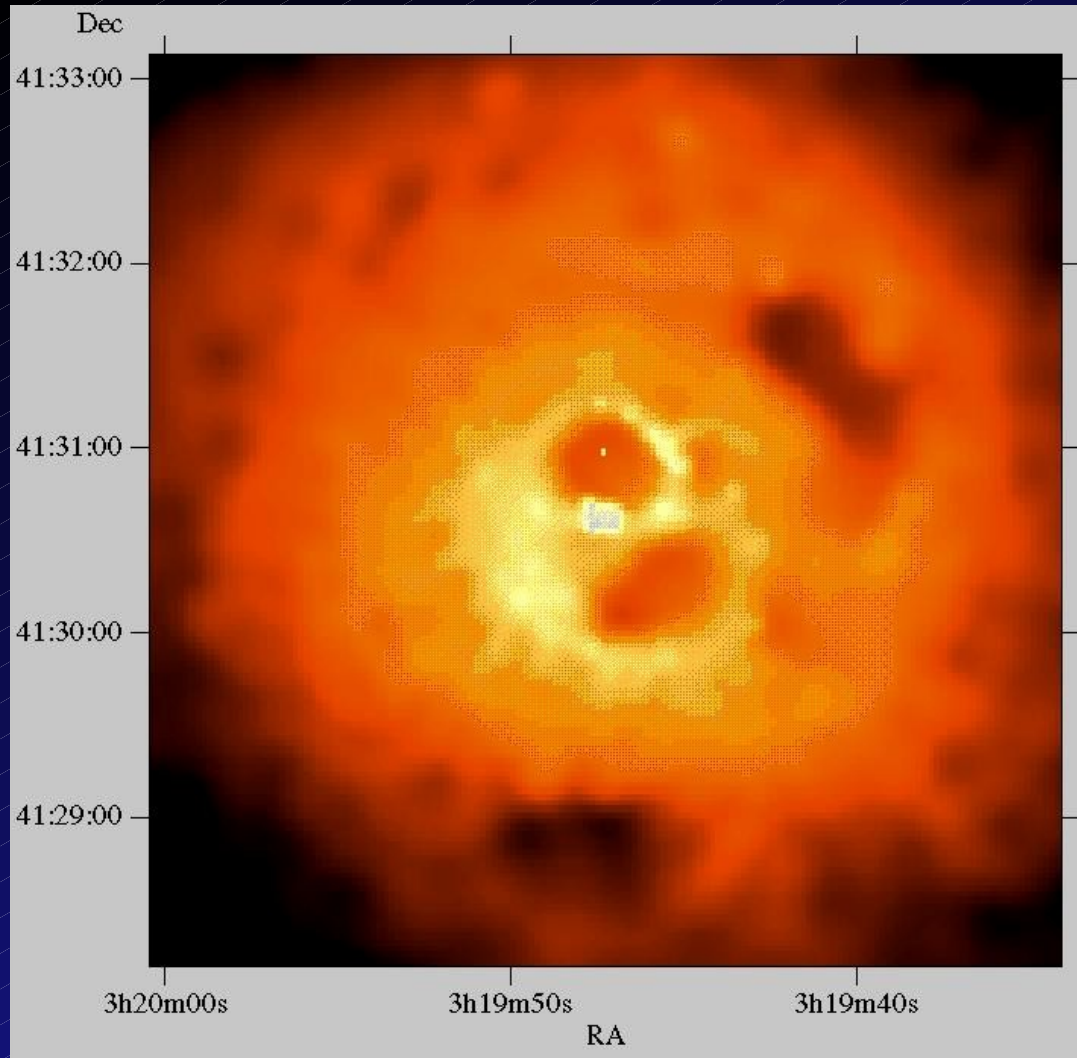
- $\beta = 3000$



Relic Radio Bubbles in Galaxy Clusters

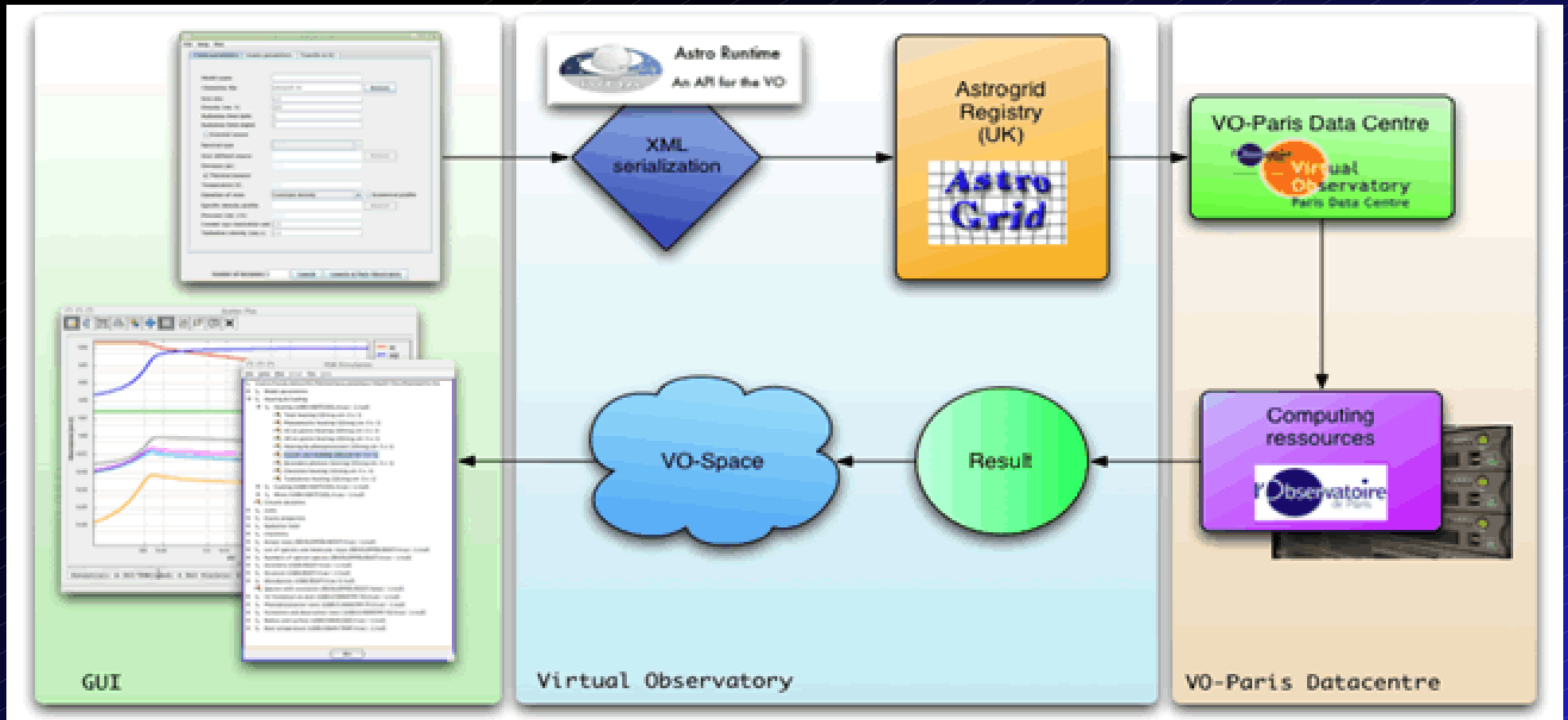
- N1275

Compare
with
Chandra
Archives



Fabian et al. 2000

PDR VO-infrasctructure



PDR database and clients

□ PDR Database

Output Files

Code produces

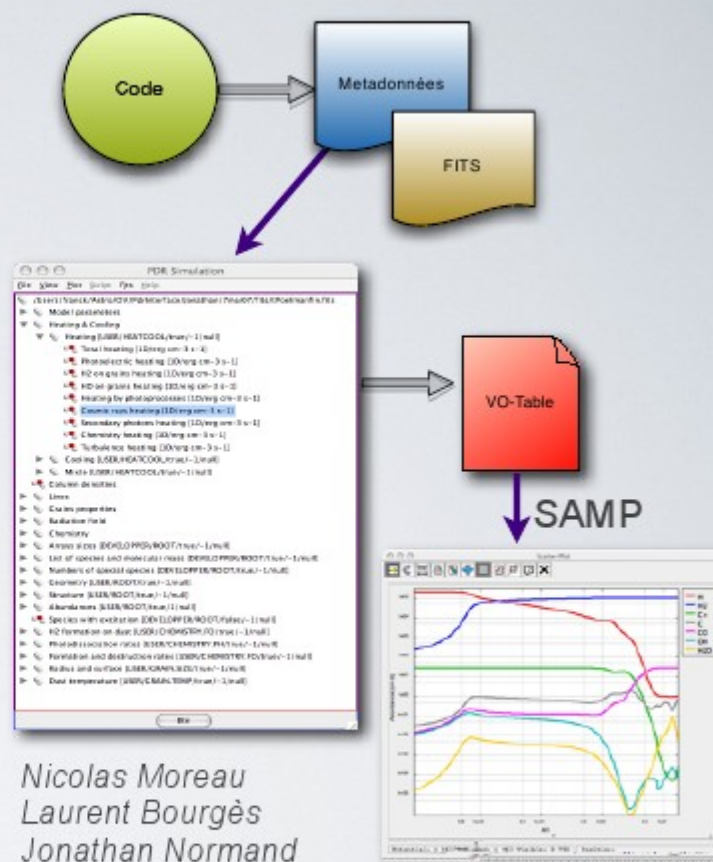
- raw data : FITS File
- XML / VO-TABLE : meta-data (name, description, units, UCD, ...)

Provide all quantities computed by the code

- observables
- theoretical quantities

PDR Analyser

- browse the computed quantities
- extraction (ASCII, VO-Table)
- SAMP
- Download data from VO-Space
- Scriptable



Nicolas Moreau
Laurent Bourguès
Jonathan Normand

PDR code via VODesktop

The screenshot displays the VO Explorer - PDR interface. On the left, there is a sidebar with 'Resource Lists' containing 'Examples', 'PDR', 'CEA', and 'New Smartlist'. Below this are sections for 'Actions' (with 'Execute Task') and 'About' (with 'Further Info' and 'Email Curator'). The main area shows 'Contents of PDR - 3 resources' with filters for 'Content - Subject', 'Coverage - Waveband', and 'Resource Type'. A table lists resources, with 'Meudon PDR code' selected. Below the table, the 'Information' tab is active, showing details for 'Meudon PDR code', including its short name, ID, type, creation and update dates, content type, subject, description, interfaces, version, dates, creator, and a creator logo. On the right, there are controls for 'Annotate' (Flag, Highlight), 'Alternative title', 'Notes', 'Tags', and 'Monitoring service'.

Status	Flag...	Title	Capability	Date
		Meudon PDR code		2007-12-14
		Meudon PDR code		2007-04-11
		VO-Paris		2007-04-11

Meudon PDR code
Short Name: Meudon PDR code ID: ivo:/obspm.fr/pdr
Type: CeaApplication Created: 1999-01-01T00:00:00 Updated: 2007-12-14T00:00:00

Content Type: other Subject: ???
The Meudon PDR code is a tool to model the physics and the chemistry of interstellar gas at stationary state. It considers a stationary plan-parallel slab of gas and dust illuminated by a UV radiation field and solves radiative transfer, thermal balance and chemistry. It is then possible to deduce column densities and emissivities to compare to observations. The exact physics in the code is described on our website. [Further information...](#)

This resource describes a **Remote Application (CEA)**
Interfaces: simple

Version: 1.0 Dates: representative: 2006-01-12
Creator: [VO Paris](#)

Monitoring service: No known providing services

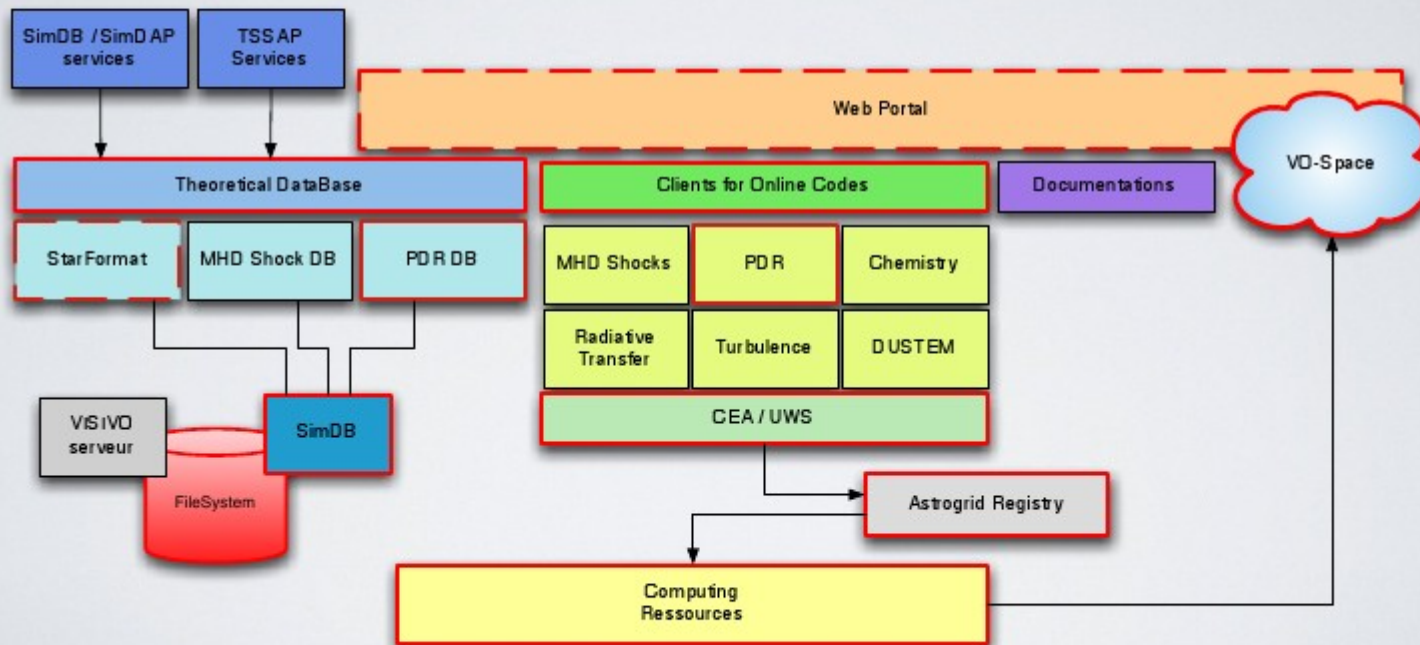
ISM platform

□ Interstellar Medium Platform

Bring together expertise in modeling / simulation of the ISM

Provide theoretical services about ISM

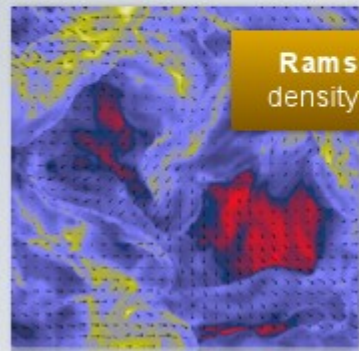
Codes - Databases - Tools & services



Complex join of TVO bricks

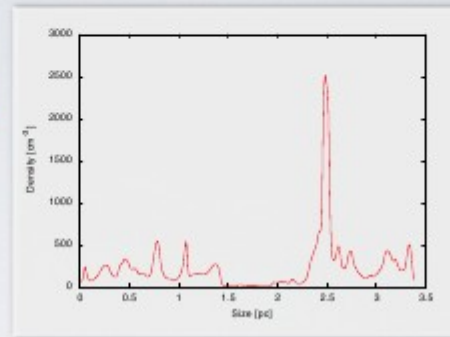
Interstellar Medium Platform

STARFORMAT project (PI: P. Hennebelle)



Ramses-MHD database
density & velocity structure

Density profile on a line of sight (3.5 pc)



SimDAP

Meudon PDR code
Chemical & thermal structure

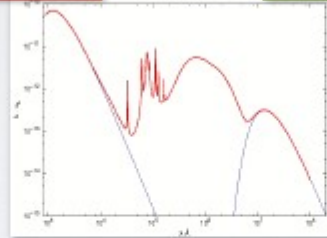
SimDAP

Radiative transfer code
Molecules excitations

Line intensity

DUSTEM
Grains emission / temperature

SLAP



SLAP

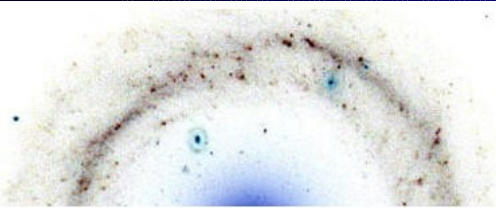


Atomic & Molecular Databases
(VAMDC)



VO Science

- 31 (9) new obscured type 2 QSO (Padovani 2004)
- Brown dwarfs (about 20 candidates)
- Brightest (WD?) Albus-1 (Cabalero et al. 2008)
- Widest CPM binaries
- AGB to PNe - 100 new (200) with VO
- SED (Spectrum Energy Distribution)
- Bolometric magnitude
- VOEvent – robotic telescopes (GRB, transits,)
- Outreach , Education (MS WWT, GoogleSky)

BDs discovered using VO



PROJECT **Brown Dwarf Search Science Prototype: Real-Time Cross Matching of Large Catalogs**

[Standards](#)
[Software & Services](#)
[Publications](#)
[Prototypes](#)

[Internal Logos](#)

ABOUT NVO

[What is the NVO?](#)
[Science Objectives](#)

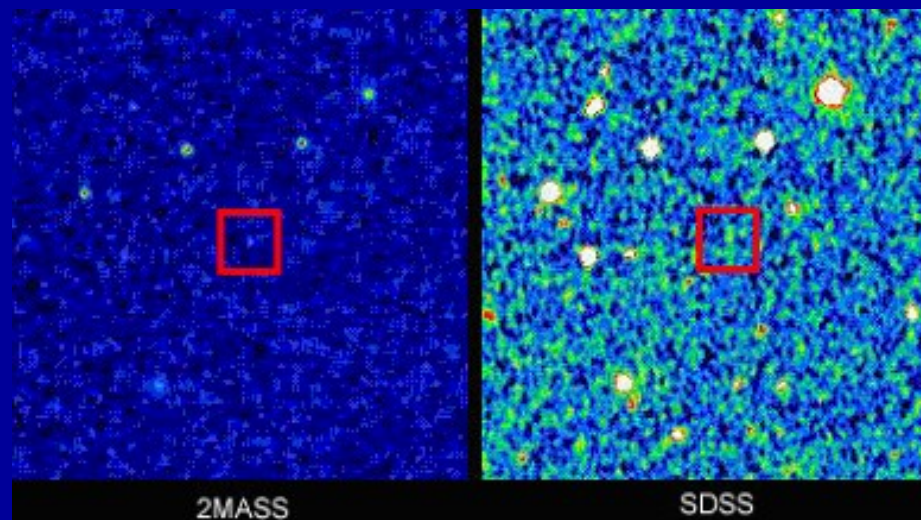
COMMUNITY **Data Resources**

- Sloan Digital Sky Survey (SDSS) Early Data Release (15 million objects)
- 2-Micron All Sky Survey (2MASS) 2nd Incremental Point Source Catalog (162 million objects)

PEOPLE **What the VO Brings** Today, doing the matching of these two large datasets is user-intensive and is replicated by many different users. Also, the correlation of these two datasets can take years of CPU time if not done correctly. The NVO brings two key aspects to

[Contact Us](#)
[Personnel](#)

- **Filtering criteria:** z & J-only detections with $z - J > 2.75$
- *SDSS: 15M obj.*
- *2MASS: 160M obj.*
- *300000 objects in common.*



✓ *However, systematic searches using a VO methodology have not been performed so far.*

Democratization of Science

- **Digital Divide**

technological barrier, data access free, access to journals

- **International Council for Science CODATA**

Committee on Data for Science and Technology – UNO ICS

- **CASPAR**

Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval
Digital curation centers

- **ADS and VO**

links to ivo://, metadata, ontologies – semantic web

- **Archive importance:**

5x IUE , 3x HST results from archives than PI articles

- **Effectiveness**

50% of published data appears in Journals, links to data automatic ?

Astroinformatics

- Analogy – Bioinformatics (Genome analysis with GRIDS, ATB)
- e-Science in Astronomy - using informatics (computer science)
- 4-th Paradigma of science (observation, experiment, modeling, knowledge)
- Data mining, Knowledge discovery - VO-NEURAL, DAME
- Clustering
- Classification
- Supervised learning (Neural Networks, SVM)
- Examples
 - Photometric RedShift
 - Searching for QSO
 - Automatic Light curves classification (GAIA, LSST)
- Very NEW – emerging discipline

Objections to VO

Data quality – garbage in - garbage out

How and whom to give credit ? (button)

embedded ivo:// data in ApJ

VO for dissemination only

technology for OPTICON, nextgen

Virtual science – VO technology

VO only for public data ! Proprietary ?

(data jealousy)

local archive - available data marked

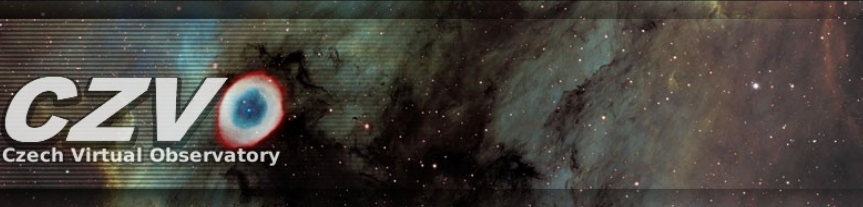
The Astronomer's Data Manifesto

at 26 IAU GA Prague SPS3

- (a) All significant tables, images, and spectra published in journals should appear in astronomical data centres.
- (b) All data obtained with publicly-funded observatories should, after appropriate pro-prietary periods, be placed in the public domain.
- (c) In any new major astronomical construction project, the data processing, storage, migration, and management requirements should be built in at an early stage of the project plan, and costed along with other parts of the project.
- (d) Astronomers in all countries should have the same access to astronomical data and information.
- (e) Legacy astronomical data can be valuable, and high-priority legacy data should be preserved and stored in digital form in the data centres.
- (f) The IAU should work with other international organisations to achieve our common goals and learn from our colleagues in other fields. ”

Czech VO - CZVO

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CZVO
Czech Virtual Observatory

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CZVO Activities

VO-KOREL (web services)

parallel run of many jobs – more users
using VO Universal Worker Server (CEA)
job control, queuing, jobs results polling
will be integrated in VODesktop

1D spectra cutout server (HEROS)

SSA access to 1D spectra + cutout of regions (lines)
normalization, (rebinning , convolution on server)

Data mining – AstroNeural + Clustering

VIRTUAL OBSERVATORY

